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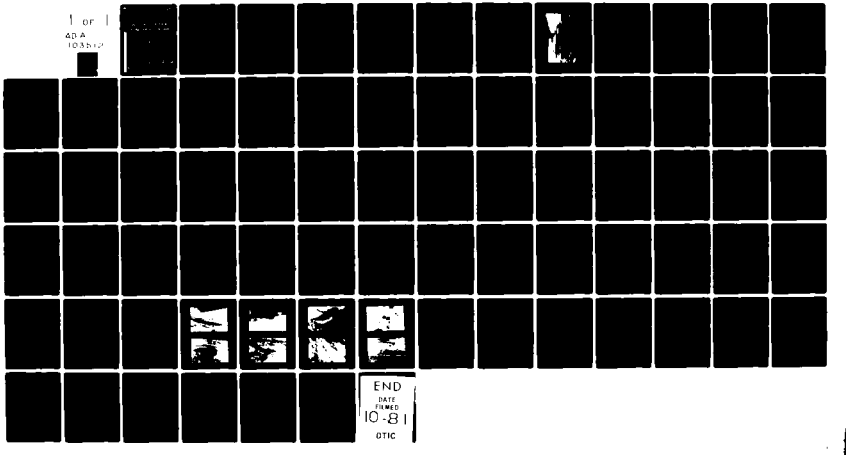
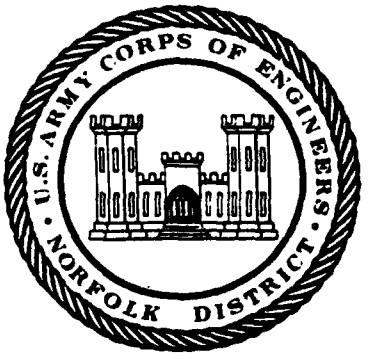


POTOMAC RIVER BASIN

Name of Dam: Unimin Tailings Dam
Location: Frederick County, Commonwealth of Virginia
Inventory Number: VA 06918

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Inspection is to indentify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspection. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam appurtenenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Unimin Tailings Dam
State: Commonwealth of Virginia
County: Frederick
USGS 7.5 Minute Quadrangle: Hayfield, Virginia
Stream: Mine Spring Run
Date of Inspection: 30 and 31 October 1980

BRIEF ASSESSMENT OF DAM

Unimin Tailings Dam is an earthfill embankment approximately 84.9 feet high[1] and 574 feet long. The principal spillway is a 30-inch bituminous coated corrugated metal pipe riser and the emergency spillway is a natural, topographic saddle on the right[2] side of the reservoir. The dam is on Mine Spring Run approximately 1.2 miles south of Gore, Virginia and is used for waste tailing storage by the owner, Unimin Corporation. Unimin Tailings Dam is an "intermediate" size-"high" hazard structure as defined by the Recommended Guidelines for Safety Inspection of Dams.

Adequate stability analyses were available for review during these investigations which evaluated the factors of safety against complete and partial failures of both the upstream and downstream embankments. All of the analyses performed indicated acceptable factors of safety against failure.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the Probable Maximum Flood (PMF) was selected as the spillway design flood (SDF). The spillways are capable of passing 100 percent of the PMF without overtopping the crest of the dam, therefore, they are adjudged as adequate.

The dam and appurtenant structures were found to be in good overall condition at the time of the inspection. Maintenance of the dam is not considered adequate. Some minor erosion has taken place below a bench on both the upstream and downstream embankments. The junction of the downstream embankment with both the left and right abutments below the bench showed moderate erosion. Some areas of the embankment and the emergency spillway are sparsely vegetated.

[1]Measured from the downstream toe of the dam to the embankment crest.
[2]Facing downstream.

A formal warning system and emergency action plan should be developed and put into operation as soon as possible. The emergency action plan should list steps to be taken to help prevent failure of the dam in an emergency.

Regular, formal inspections should be made of the dam and appurtenant structures. A check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be completed annually.

The following repair items should be accomplished as part of the general maintenance of the dam:

1) Repair all areas of erosion on the embankment, particularly the erosion rills on the downstream embankment below the bench.

2) Establish a grass cover over all the sparsely vegetated areas of the embankment.

3) Repair and riprap the eroded junctions of the left and right abutments with the downstream embankment.

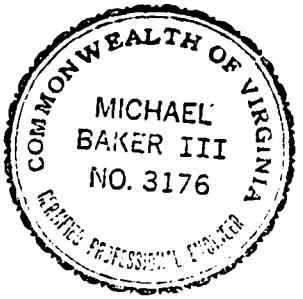
4) Uncover the outlet pipes for the internal chimney and lateral seepage control drains.

5) Establish a grass cover over the sparsely vegetated areas of the emergency spillway.

6) Install a staff gage to monitor reservoir levels above normal pool.

MICHAEL BAKER, JR., INC.

Michael Baker, III, P.E.
Chairman of the Board and
Chief Executive Officer



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Date: JAN 30 1981

NAME OF DAM: UNIMIN TAILINGS DAM

OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: UNIMIN TAILINGS DAM ID# VA 06918

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsbility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 12, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project:

1.2.1 Description of Dam and Appurtenances: Unimin Tailings Dam is an earthfill embankment approximately 84.9 feet high and 574 feet long.[1] The crest of the dam is about 21.6 feet wide and the minimum elevation is at 920.6 feet Temporary Bench Mark (T.B.M.).[2] The upstream embankment has a 12 foot wide bench about 17 feet below the crest of the dam at about elevation 904.0 feet. The slope of the upstream embankment is approximately 2.5H:1V (Horizontal to Vertical) above the bench and 2.8H:1V below the bench. The downstream embankment has a 12 foot wide bench about 30 feet below the crest of the dam. The slope of the downstream embankment is approximately 2.5H:1V above the bench and

[1]Measured from the downstream toe of dam to the lowest point on the embankment crest.
[2]All elevations are referenced to a Temporary Bench Mark located on the top of a concrete marker on the top of dam, right abutment. The assumed elevation is 921.0 feet.

2.6H:1V below the bench. There is no slope protection on the upstream embankment.

According to the As-Built Report (Reference 18, Appendix IV), a key trench was excavated into the foundation soils near the upstream toe of the embankment and backfilled with compacted clayey soils. The embankment was constructed of on-site borrow materials from upstream of the dam. The As-Built Report indicates that chimney and lateral drains were constructed for internal embankment drainage.

The principal spillway is a 30-inch diameter bituminous coated corrugated metal pipe (B.C.C.M.P.) serving as a fixed riser. According to the owner's representative, the top portion of the 30-inch riser was broken and a 42-inch diameter pipe was placed over the existing pipe and anchored with cables. Concrete was used to fill the space between the 30-inch diameter pipe and the 42-inch diameter pipe.

The spillway riser has a crest elevation of 901.0 feet T.B.M. The riser is located to the right of center of the embankment.[3] A trash rack has been fitted to the top of the riser. According to the As-Built Report, the riser extends down about 39 feet where it connects to a 24-inch diameter B.C.C.M.P. outlet. The 24-inch B.C.C.M.P. is approximately 414 feet long and passes beneath the embankment at a slope of approximately 5.5 percent. This pipe exits into a riprap lined plunge pool at the center of the downstream toe of the embankment. The outlet pipe extends about 5.5 feet beyond the embankment. This extension is unsupported. The invert elevation at the principal spillway outlet is at 838.7 feet T.B.M. The tailwater elevation in the plunge pool is at 836.2 feet T.B.M.

A gate valve with accompanying valve stem extension and support brace is attached to the spillway riser pipe approximately four feet below the crest of the riser pipe (Photo 1). This valve is used during periods

[3]Facing downstream.

of low flow to maintain the water supply into the fresh water pond located downstream.

The emergency spillway makes use of the natural depression in a topographic saddle located to the right and upstream of the embankment. Flood discharges would pass through this saddle and return to Mine Spring Run 1.5 miles downstream of the dam. In addition to the natural depression, some excavation and clearing has been done in the emergency spillway. A discharge channel approximately 6 feet deep and 24.5 feet wide was excavated through the saddle. A temporary access road was constructed across this discharge channel, filling in a portion of the channel and giving the emergency spillway an effective minimum elevation of 903.6 feet T.B.M. (Photo 2).

The reservoir is fed by runoff and springs from a 2.03 square mile drainage area south and east of the dam. Mine Spring run drains the watershed from the south and a small unnamed tributary drains from the east. The upper reaches of the watershed are densely wooded, very steep slopes of Great North Mountain. The lower reaches, while less steep, are also densely wooded.

There are no facilities for draining the reservoir.

1.2.2 Location: Unimin Tailings Dam is located in Frederick County, Virginia approximately 1.2 miles south of Gore, Virginia on Mine Spring Run, a tributary to Back Creek. A Location Plan is included in this report in Appendix I.

1.2.3 Size Classification: The Unimin Tailings Dam is 84.9 feet high and the reservoir storage at the crest of the dam (elevation 920.6 feet T.B.M.) is 1,102 acre-feet. Therefore, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.2.4 Hazard Classification: Three homes are located approximately 1.0 miles downstream of the dam. A business (C. E. Minerals) is

located approximately 1.2 miles downstream and three more homes are situated about 1.4 miles downstream of the dam. There is danger of loss of human life from large flows downstream of the dam. Therefore, Unimin Tailings Dam is in the "high" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and is not related to its stability or probability of failure.

1.2.5 Ownership: The dam is owned by Unimin Corporation, P.O. Box 38, Gore, Virginia 22637.

1.2.6 Purpose: The dam is used to provide waste tailing storage for the mining and milling of glass sand by Unimin Corporation.

1.2.7 Design and Construction History: The dam was designed by D'Appolonia Consulting Engineers, Inc. in 1976. The dam was constructed by Perry Engineering Company in the fall of 1976 and spring of 1977.

1.2.8 Normal Operating Procedures: The reservoir is normally operated at the crest of the principal spillway (elevation 901.0 feet T.B.M.). A gate valve (as described in Section 1.2.1) can be operated during periods of low flow to lower the level in the reservoir approximately 4 feet in order to maintain the water supply into the fresh water pond located downstream. No formal operating procedures are followed for this dam.

1.3 Pertinent Data

1.3.1 Drainage Area: The drainage area tributary to the dam is 2.03 square miles.

1.3.2 Discharge at Dam Site: The maximum discharge from the reservoir is unknown.
Principal and Emergency Spillways:
Pool level at top of dam . . . . 46,011 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are provided in the following table:

NAME OF DAM: UNIMIN TAILINGS DAM

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation (feet T.B.M.)	Reservoir Capacity Area (acres)	Reservoir Capacity Acre-feet	Reservoir Capacity Watershed (inches)	Length (feet)
Top of Dam (minimum)	920.6	36.7	1102	10.2	1950
Principal Spillway Crest	901.0	23.0	518	4.8	1400
Streambed at downstream toe of dam	835.7	-	-	-	-

NAME OF DAM: UNIMIN TAILINGS DAM

SECTION 2 - ENGINEERING DATA

2.1 Design: The site was selected and the impoundment was designed by D'Appolonia Consulting Engineers, Inc. Subsurface conditions were investigated and the embankment was designed to provide maximum strength for stability. Stability analyses were conducted and factors of safety were calculated and are explained in detail in Section 6 - Dam Stability (also see Plates 9 and 10, Appendix I). Control of seepage was provided by an upstream impervious blanket, a cut-off beneath the embankment, downstream lateral drains, and an internal chimney drain within the embankment. The embankment design and construction is presented on Plates 2 and 3 in Appendix I. Boring and Test Pit locations are shown on Plate 6. Soils information and subsurface conditions are shown on Plates 7 and 8.

The principal and emergency spillways were designed to decant clarified water and discharge flood peaks. The principal spillway was designed as two 30-inch diameter vertical inlet pipes connected to a 24-inch diameter pipe passing beneath the embankment. However, during the field investigation, only one 42-inch diameter vertical inlet pipe connected to a 24-inch diameter outlet pipe was observed. A plunge pool was designed to still water exiting from the outlet pipe. An emergency spillway was designed to use the natural topographic saddle on the right side of the reservoir to discharge flood flows. The principal and emergency spillway designs and pertinent information are shown on Plates 4, 5, and 11 in Appendix I.

2.2 Construction: The dam was constructed by Perry Engineering Company in the fall and early winter of 1976 and spring of 1977. A majority of the construction was inspected by D'Appolonia Consulting Engineers' representatives. The upstream embankment materials (typically clayey) were placed and compacted at moisture contents 5 to 6 percent above optimum according to the Standard Proctor Method (ASTM D698-70) to allow for expected differential settlement over variable foundation and abutment materials without detrimental affects to the water retention capabilities. The downstream embankment materials (typically sandy) were placed at moisture contents just slightly (2 to 3 percent) above optimum to also allow for differential movement between the valley floor and abutments. However, they were not placed as wet as the upstream embankment materials to provide the necessary strength and stability for the structure.

Fill was placed in lifts of 6 to 9 inches. Compaction was achieved with 6 to 8 passes of a Caterpillar 815 compactor and Bros. SP-255 DA compactor. Much of the fill placement was observed by a D'Appolonia engineer. Periodic fill density testing was completed by D'Appolonia when a representative was present. The densities were compared to the results of Standard Proctor Tests conducted on various samples of borrow to provide comparison of fill densities to maximum densities and optimum water contents. Recompaction was conducted in areas where tests indicated unsatisfactory compaction. In areas where fill placement was not inspected by the engineer, borings were taken to obtain undisturbed samples of the fill that were tested for density. The available summary of all density test results indicates final densities were in excess of 93 percent of maximum dry density.

Four piezometers and four settlement plates were installed beneath the upstream embankment area prior to construction to monitor foundation behavior and groundwater levels.

Eight additional piezometers were installed beneath and within the downstream embankment after construction to monitor actual water levels for comparison with assumed design water levels. The locations and depths of the upstream piezometers and settlement plates are shown on Plates 2 and 7 in Appendix I and are designated as I-1 through I-4 (both a piezometer and an adjacent settlement plate were assigned the same identification number). The locations and depths of the eight downstream piezometers, designated B-1 through B-6, are also shown on Plates 2 and 7. Typical piezometer and settlement plate construction details are shown on Plate 5.

During the construction of approximately the lower one-third of the embankment, no extensive differential settlement reportedly occurred. However, settlement measurements were not taken thereafter. Measurements in the piezometers during and after construction do not indicate detrimental water levels within the embankment.

A key trench, varying between 5 feet to 13 feet deep and 17 to 23 feet wide, was excavated into the foundation soils near the upstream toe of the dam using normal excavating techniques. The trench did not extend to bedrock. Depth of the trench was governed by the original groundwater level and was shallow in the creek area. Initial clayey backfill could not be compacted in thin lifts due to water levels in the

trench. The initial lift was as thick as four feet and was compacted as well as possible. After the first lift, the trench was backfilled in 9 to 12 inch thick layers compacted to specified density. In addition to the key trench, an impervious blanket of clayey soil was placed over the toe of the upstream embankment, the immediate reservoir bottom, and the upstream abutments. The extent of the key trench and impervious blanket are illustrated on Plates 2 and 3.

2.3 Evaluation: The as-built drawings, design information and construction information were adequate to assess all aspects of design and construction. The hydrologic and hydraulic data provided were adequate for review. The assessments made in this report are based on this engineering data along with field observations.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The field inspection was conducted on 30 and 31 October 1980. At the time of inspection, the pool elevation was 897.4 feet T.B.M. and the elevation of the tailwater in the stilling basin for the principal spillway was 836.2 feet T.B.M. The weather was clear with temperatures in the 50's (degrees Fahrenheit). The ground surface of the embankment and abutments was generally dry. The dam and appurtenant structures were found to be in fair to good overall condition at the time of the inspection. Deficiencies found during the inspection will require remedial treatment. The following are brief summaries of deficiencies found during the inspection. A field sketch of conditions noted during the inspection is presented as Plate 1 in Appendix I. The complete visual inspection check list is provided in Appendix III. Control surveys of the dam are performed regularly but were unavailable for this report. In addition, state Mining Inspectors visually review the dam as part of their regular inspections.

3.1.2 Dam: The embankment was found to be in generally good condition, with no surface cracks or sloughs. The bench on the upstream embankment and the embankment above the bench are well vegetated with grass and are not eroded. The upstream embankment bench appears to be a reverse terrace and water appears to have lain on the back side of the bench periodically. Minor erosion has occurred just below the bench down to the edge of water. This segment is below normal pool level. The downstream embankment is benched. Above this bench there are a few erosion rills. Generally, these rills do not extend to the crest of the dam. With the exception of the rills, the downstream embankment above the bench is well vegetated. The downstream embankment below the bench is moderately eroded. Erosion rills up to one foot deep extend from the bench to the toe of the dam. The downstream embankment below the bench has many areas of sparse vegetation.

The junctions of the abutments and the upstream embankment are not eroded. The right upstream abutment contains the access roads to the upstream bench and crest of the dam. The slopes for the access roads are very steep and appear to be subject to erosion and minor slides. The access roads are primarily cut into bedrock and are generally situated on the abutment rather than the dam. The junctions of the abutments and the downstream embankment are slightly to moderately eroded. Moderate erosion occurs from the toe of the dam about three quarters of the way up to the bench on both the left and right abutment junctions.

A seep is located immediately to the left of the principal spillway outlet. The flow rate of this seep was estimated to be three to five gallons per minute (g.p.m.). This seepage is believed to be from a sediment covered outlet pipe for the internal chimney and lateral seepage relief drainage system. In the past, runoff from the junction of the left abutment with the downstream embankment was directed through a separate diversion channel away from the approximate area of this outlet. However, runoff now discharges over the outlet area and sediment has probably covered the pipe. A very minor seep is located beneath the decant outlet pipe. No other seepage or drainage was observed at the time of inspection.

3.1.3 Appurtenant Structures: The principal spillway riser and accompanying gate valve (as described in Section 1.2.1) appear to be in good condition and operable. The outlet pipe for the principal spillway is in good condition, although the pipe does extend, unsupported, out from the embankment approximately 5.5 feet. The plunge pool discharge area for the principal spillway is also in good condition. The principal spillway inlet, outlet, discharge area and downstream channel are all free from debris and other obstructions.

The emergency spillway (as described in Section 1.2.1) is primarily a natural topographic saddle and is in relatively good

condition. The saddle has been cleared and some areas of the spillway have been excavated for a discharge channel while other areas have been filled. No significant signs of erosion were observed, although vegetation is sparse, particularly on the excavation and fill areas. The emergency spillway, with the exception of the temporary access road across the discharge channel, is free from debris and is unobstructed.

3.1.4 Reservoir Area: The slopes immediately surrounding the reservoir are steep and heavily wooded. The banks of the reservoir are well vegetated with grasses and some trees down to the edge of the banks. No indications of significant erosion were observed. Soundings taken at the principal spillway riser show the water to be approximately 5 feet deep at the time of inspection.

3.1.5 Downstream Channel: Discharge from the principal spillway of Unimin Tailings Dam flows into the reservoir for the Unimin Fresh Water Pond Dam almost immediately after leaving the discharge area. The short length of discharge channel is free from debris or other obstructions. Beyond the Fresh Water Pond Dam, the downstream channel is a natural stream channel, known as Mine Spring Run, which drains into Back Creek at the town of Gore, Virginia. There is some minor debris and miscellaneous junk present in the channel immediately downstream of the Fresh Water Pond Dam.

3.1.6 Instrumentation: Eight piezometers were observed on the dam at the time of inspection. Five piezometers were on the crest of the dam; one at either end and a cluster of three near the center. The piezometer on the left end of the crest measured 60 feet to the bottom with no water. The piezometer on the right end of the crest and the three clustered near the center were plugged near the surface and could not be measured.

The remaining three piezometers were clustered near the center of the bench on the downstream embankment. The piezometer with the highest elevation could not be measured because of

equipment malfunction. The next lower piezometer measured 15.17 feet to the bottom with no water. The lowest piezometer measured 32.87 feet to the bottom with no water.

There was no other instrumentation observed at the dam during the inspection.

3.2 Evaluation: The embankment was found to be in generally fair to good condition, with no surface cracks or sloughs. All areas of erosion on the embankment should be repaired, particularly the erosion rills below the bench on the downstream embankment. A grass cover should be established on all the sparsely vegetated areas of the embankment. The eroded junctions of the left and right abutments with the downstream embankment should be repaired and riprap placed to minimize erosion. The drains for seepage control that are reportedly located to the left and right of the principal spillway outlet should be uncovered.

The appurtenant structures were found to be in generally good condition. A grass cover should be established throughout the natural saddle that comprises the emergency spillway. A staff gage should be installed to monitor reservoir levels above normal pool.

SECTION 4 - OPERATION PROCEDURES

4.1 Procedures: The operation of the dam is primarily an automatic function controlled by the principal and emergency spillways. Water entering the reservoir flows into the principal spillway at elevation 901.0 feet T.B.M. When inflow is sufficient, the reservoir level rises above elevation 903.6 feet T.B.M. and discharges through the emergency spillway. When inflow is insufficient to meet the water needs downstream, the gate valve attached to the principal spillway riser can be operated to lower the reservoir approximately four feet below the crest of the principal spillway.

4.2 Maintenance of Dam: Maintenance of the dam is the responsibility of the owner. Brief daily inspections are made by the owner. Also, the alignment of the crest and elevations are surveyed regularly. However, a formal inspection and maintenance schedule has not been instituted.

4.3 Maintenance of Operating Facilities: The only operating facility at the dam is the gate valve attached to the spillway riser. The maintenance of this facility is the responsibility of the owner. A formal inspection and maintenance schedule has not been instituted.

4.4 Warning System: At the present time, there is no warning system or emergency action plan in operation.

4.5 Evaluation: Past maintenance of the dam has been inadequate. Regular, formal inspections should be made of the dam and appurtenant structures. A check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be corrected annually. A warning system and emergency action plan should be developed and put into operation as soon as possible.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: Hydraulic and hydrologic design data were provided by D'Appolonia Consulting Engineers, Inc. in the form of an As-Built Report (Reference 18, Appendix IV). The hydraulic and hydrologic data provided were adequate for review and are presented on Plates 4, 5 and 11 of this report.

5.2 Hydrologic Information: No rainfall, stream gage or reservoir stage records are maintained for this dam.

5.3 Flood Experience: No records were available.

5.4 Flood Potential: The Probable Maximum Flood (PMF) and 1/2 Probable Maximum Flood (1/2 PMF) were routed through the reservoir by the use of the HEC-1 DB computer program (Reference 9, Appendix IV) and appropriate unit hydrograph, precipitation, and storage-outflow data. Clark's T_c and R coefficients for the local drainage areas were estimated from basin characteristics. The rainfall applied to the unit hydrograph was taken from publications by the U.S. Weather Bureau and the National Oceanic and Atmospheric Administration (References 16 and 17, Appendix IV). Rainfall losses for the PMF and 1/2 PMF were estimated at an initial loss of 1.0 inches and a constant loss rate of 0.05 inches per hour thereafter.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are provided in Table 1.1, paragraph 1.3.3.

Regulation of flow from the reservoir is primarily automatic. Normal flows are maintained by the crest of the principal spillway at elevation 901.0 feet T.B.M. Some manual regulation of flow is possible by the operation of the gate valve attached to the principal spillway riser which is approximately four feet below the spillway crest.

The outlet discharge capacity was computed by hand; reservoir area was planimetered from the Hayfield, Virginia, 7.5 minute USGS quadrangle; and storage capacity was computed by the HEC-1 DB program. Outlet discharge capacity and storage capacity curves were computed to elevations above the crest of the dam. All flood routings were begun with the dam at normal pool. Flow through both spillways was included in the routings.

5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance are shown in the following table:

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal[1]	Hydrographs 1/2 PMF	Hydrographs PMF[2]
Peak flow, c.f.s.			
Inflow	1	7,177	14,353
Outflow	1	7,001	14,105
Peak elev., ft. T.B.M.	897.4	909.3	911.7
Emergency spillway[3] (elev. 903.6 ft. T.B.M.)			
Depth of flow, ft.	-	5.7	8.2
Average velocity, f.p.s.	-	11.1	13.3
Duration of flow, hrs.	-	25.0	30.7
Non-overflow section[3] (elev. 920.6 ft. T.B.M.)			
Depth of flow, ft.	-	-	-
Average velocity, f.p.s.	-	-	-
Total duration of overtopping, hrs.	-	-	-
Tailwater elev., ft. T.B.M.	836.2	-	-

[1] Conditions at time of inspection.
[2] The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in a region.
[3] Velocity estimates were based on critical depth at control section.

5.7 Reservoir Emptying Potential: There are no facilities for draining the reservoir.

5.8 Evaluation: Unimin Tailings Dam is an "intermediate" size - "high" hazard dam requiring evaluation for a spillway design flood (SDF) equal to the PMF. The spillways are capable of passing 100 percent of the PMF without overtopping the crest of the dam. The spillway is adjudged as adequate.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The dam is located in the Valley and Ridge physiographic province of Virginia which is characterized by folded and faulted sedimentary rocks. Bedrock in the vicinity of the dam consists of steeply dipping late Silurian to early Devonian age limestone, sandstone (Oriskany), and shale. The Oriskany sandstone is clearly exposed on the northern abutment. The actual foundation for the dam consists of thick combination residual, alluvial, and colluvial soils according to the As-Built Report (Reference 18, Appendix IV). The principal soils underlying the dam are clayey silts. Some sandy soils are present.

The dam foundation was not keyed into bedrock. Seepage control consists of a 17 to 23 foot wide, by 5 to 13 foot deep key trench excavated into the foundation soils near the upstream toe of the dam and backfilled with compacted clayey soils. In addition, an impervious blanket of clayey soils was placed over the toe of the upstream embankment, the immediate reservoir bottom, and the upstream abutments.

6.2 Embankment

6.2.1 Materials: According to the available as-built report, the embankment materials range from clayey to sandy soils. The clayey soils were placed on the upstream side of the structure. The sandy soils were placed on the downstream side of the structure. Brown silt with a little fine to medium sand and numerous sandstone fragments (ML group soil-Unified Classification System) was noted as the typical soil on the downstream embankment during the field inspection. Most of the soil samples classified by D'Appolonia from test pits in the borrow area were ML group soils.

6.2.2 Stability: Stability analyses were conducted by D'Appolonia Consulting Engineers, Inc. using a computerized version of Bishop's Method of Slices. Analyses were conducted to address short term conditions occurring during construction (not applicable now) and long term conditions. Shear strength values of representative embankment and foundation materials used in the analyses were derived

from laboratory consolidated undrained triaxial shear tests, direct shear strength tests, and field investigations. The values for the long term analyses are as follows:

Generalized Soil Description	Material	Angle of Internal Friction (Ø)	Cohesion (C(p.s.f.))
Clayey Silt Borrow 2% to 3% Above Optimum	Embankment	28°	0
Clayey Silt Borrow 5% to 6% Above Optimum	Embankment	26°	400
Boulders, Rock Fragments, Some Silty Sand	Foundation	34°	0
Clayey Silt, Some Rock Fragments	Foundation	25°	200
Soft Clayey Silt, Some Rock Fragments	Foundation	24°	500
Clayey Sand, Some Rock Fragments	Foundation	30°	0

Individual analyses were made for failures within the upstream and downstream embankments and failures through the foundation soils on the upstream and downstream sides. The configuration of the dam used in these analyses is the same as the as-built configuration. The phreatic surface was assumed to be controlled by the internal chimney drain and downstream lateral drains. Measurements taken in the piezometers that were not clogged during the field inspection generally show that the phreatic surface is lower than that assumed during the stability analyses and indicate that the drainage system is performing satisfactorily. The factor of safety calculated against the four failure cases described above are as follows:

Type of Failure	Factor of Safety Against Failure
Downstream Embankment Failure From Crest to Bench	1.46
Failure Through Foundation Affecting Entire Downstream Embankment and Crest of Dam	1.72
Upstream Embankment Failure Affecting Crest and Upper 3/4 of Embankment	2.16
Failure Through Foundation Affecting Entire Upstream Embankment and Crest of Dam	2.71

The visual inspection of the structure revealed no signs of instability such as slumping, tension cracks, or unusual alignment along the crest. However, moderate erosion of the downstream embankment (primarily below the bench) has occurred and should be corrected to prevent additional damage that could affect the stability of the existing slopes. The as-built plans indicate that there should be two 8-inch C.M.P. outlets, one on each side of the principal spillway outlet, for the internal chimney drain and lateral drains within the downstream embankment. Neither of these pipes was observed during the visual inspection. A discharge (3-5 g.p.m.) was occurring from the approximate area of the left drain. No discharge was occurring from the approximate area of the right drain. The outlets may have been covered over by sediment eroded from the embankment above the drains. It is not clear from available information describing construction history whether the drains were constructed as designed. If the two outlets were constructed as designed, they should be uncovered and cleaned out to ensure proper operations.

6.2.3 Seismic Stability: The dam is located in Seismic Zone 2 which presents no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams by the Department of the Army, Office of the

Chief of Engineers. This determination is contingent on the requirements that static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: The design of the dam is such that acceptable factors of safety against failure have been provided. The existing configuration of the embankment is the same as that assumed during stability analyses conducted during design. The visual inspection did not indicate any stability problems. Only minor maintenance is required to ensure structural integrity. Measurements taken in the existing piezometers that were not clogged revealed that the phreatic surface is adequately controlled by the internal drainage system. Adequate stability analyses, considering the present conditions of the dam, have been conducted.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: The engineering data provided were adequate to assess the design and construction of Unimin Tailings Dam. Hydraulic and hydrologic data provided were adequate for review. Adequate stability analyses were available for review during these investigations which indicated acceptable factors of safety against failure. Deficiencies discovered during the field inspection and office analyses will require remedial treatment. The dam and appurtenant structures are generally in good overall condition. Maintenance of the dam is not considered adequate.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the PMF was selected as the SDF for the "intermediate" size - "high" hazard classification of Unimin Tailings Dam. The spillways are capable of passing 100 percent of the PMF without overtopping the crest of the dam and are adjudged as adequate.

Some minor erosion has taken place below the benches on both the upstream and downstream embankments. The junction of the downstream embankment with both the left and right abutments below the bench showed moderate erosion. Some areas of the embankment and the emergency spillway are sparsely vegetated. The seepage control drain outlets have been covered by sediment. The principal spillway outlet extends unsupported over the plunge pool.

There is no warning system or emergency action plan currently in operation.

7.2 Recommended Remedial Measures: A formal warning system and emergency action plan should be developed and put into operation as soon as possible. The emergency action plan should list steps to be taken to help prevent failure of the dam in an emergency.

Regular, formal inspections should be made of the dam and appurtenant structures. A check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be completed annually.

The following repair items should be accomplished as part of the general maintenance of the dam:

1) Repair all areas of erosion on the embankment, particularly the erosion rills on the downstream embankment below the bench.

2) Establish a grass cover over all the sparsely vegetated areas of the embankment.

3) Repair and riprap the eroded junctions of the left and right abutments with the downstream embankment.

4) Uncover the outlet pipes for the internal chimney and lateral seepage control drains.

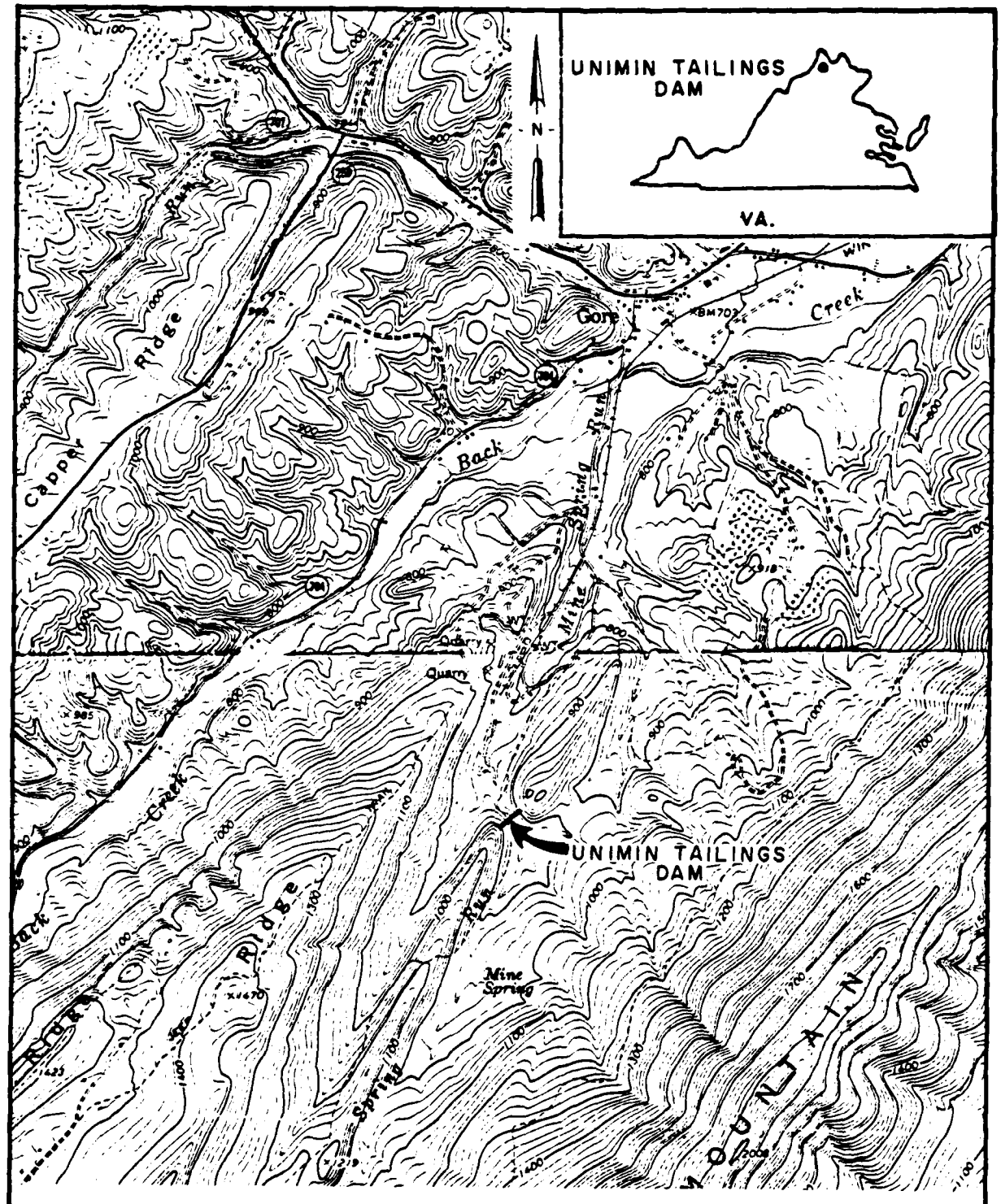
5) Establish a grass cover over the sparsely vegetated areas of the emergency spillway.

6) Install a staff gage to monitor reservoir levels above normal pool.

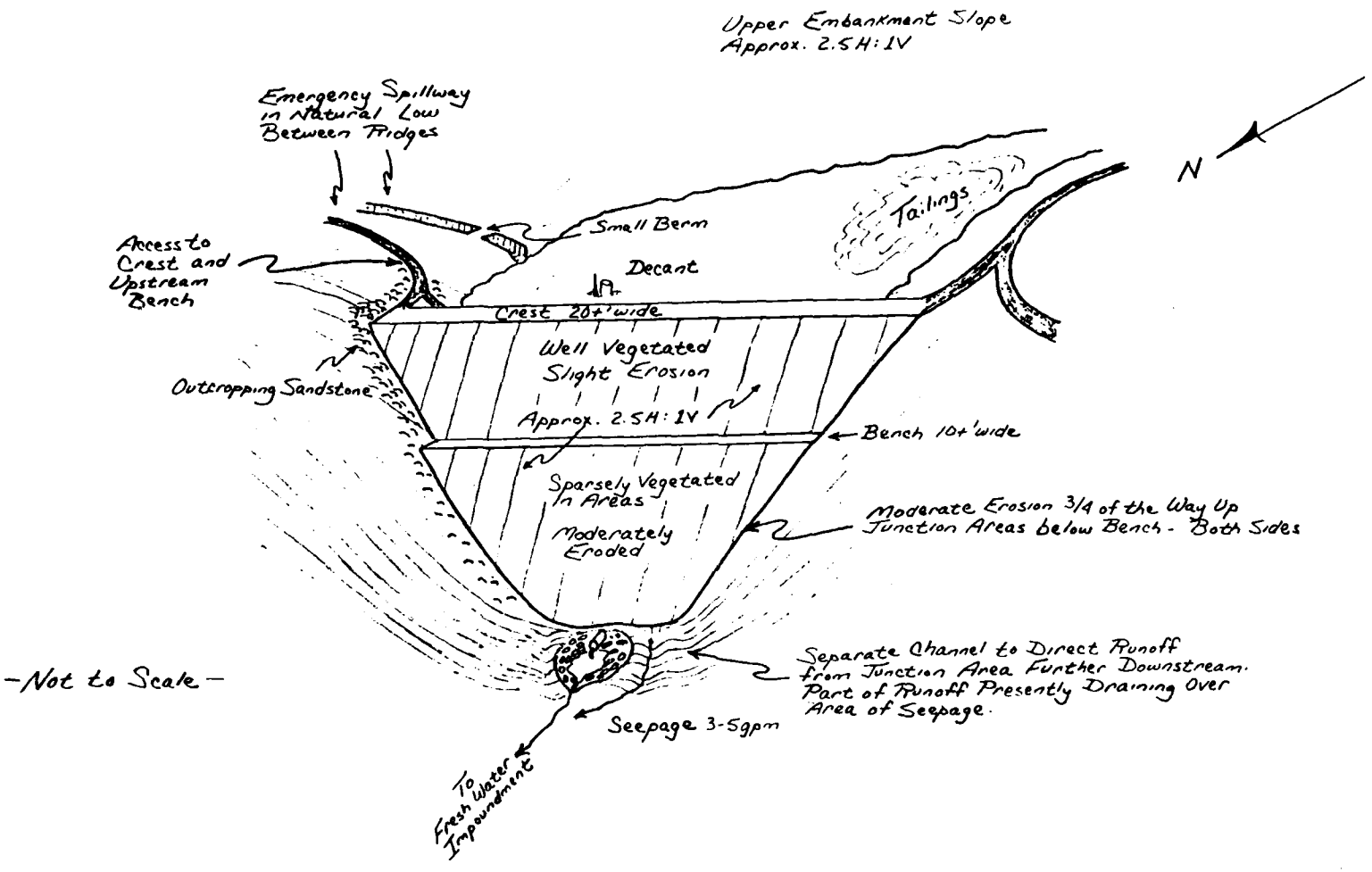
APPENDIX I

PLATES

CONTENTS



LOCATION PLAN



FIELD SKETCH

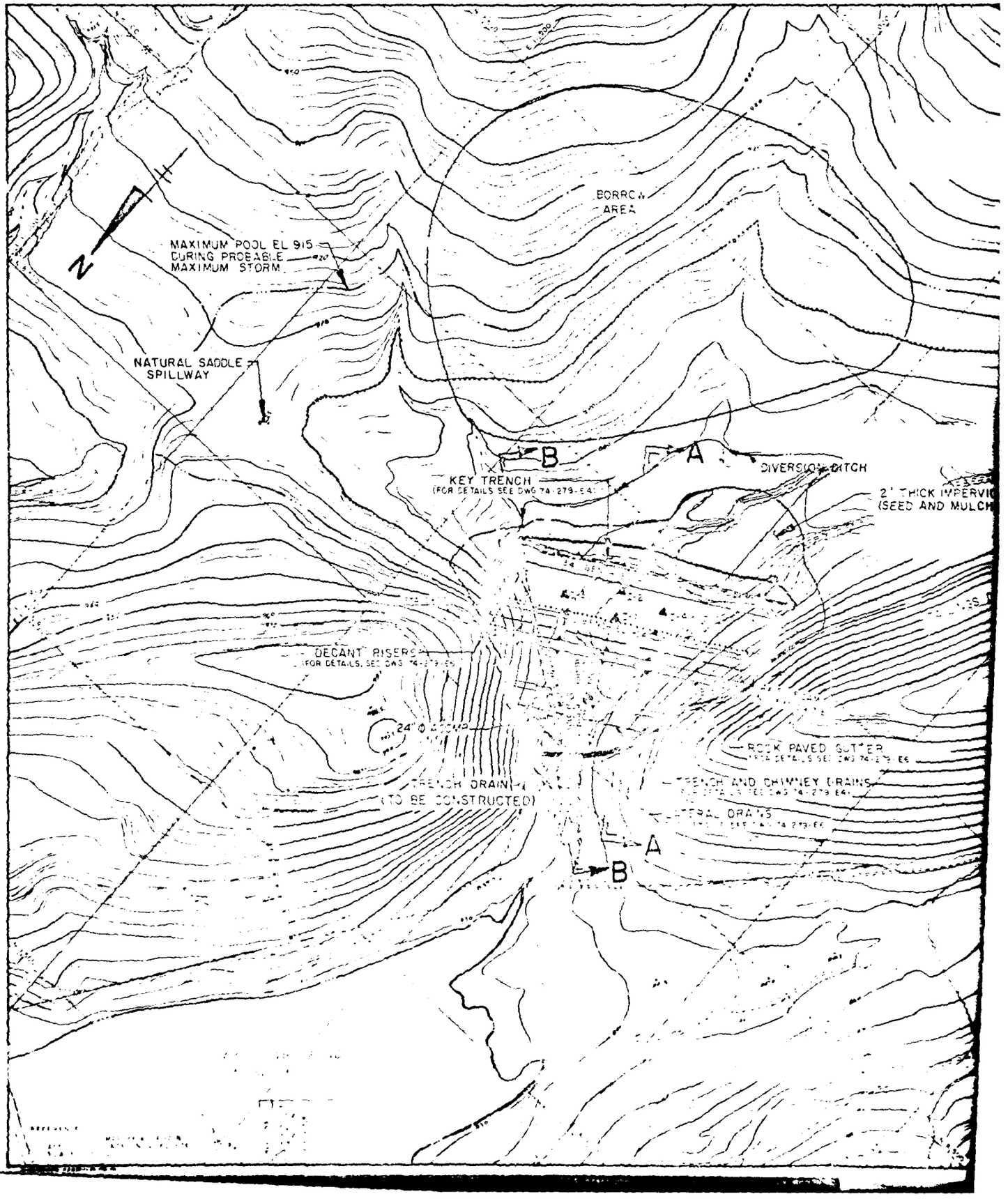
UNIMIN TAILINGS DAM, VIRGINIA

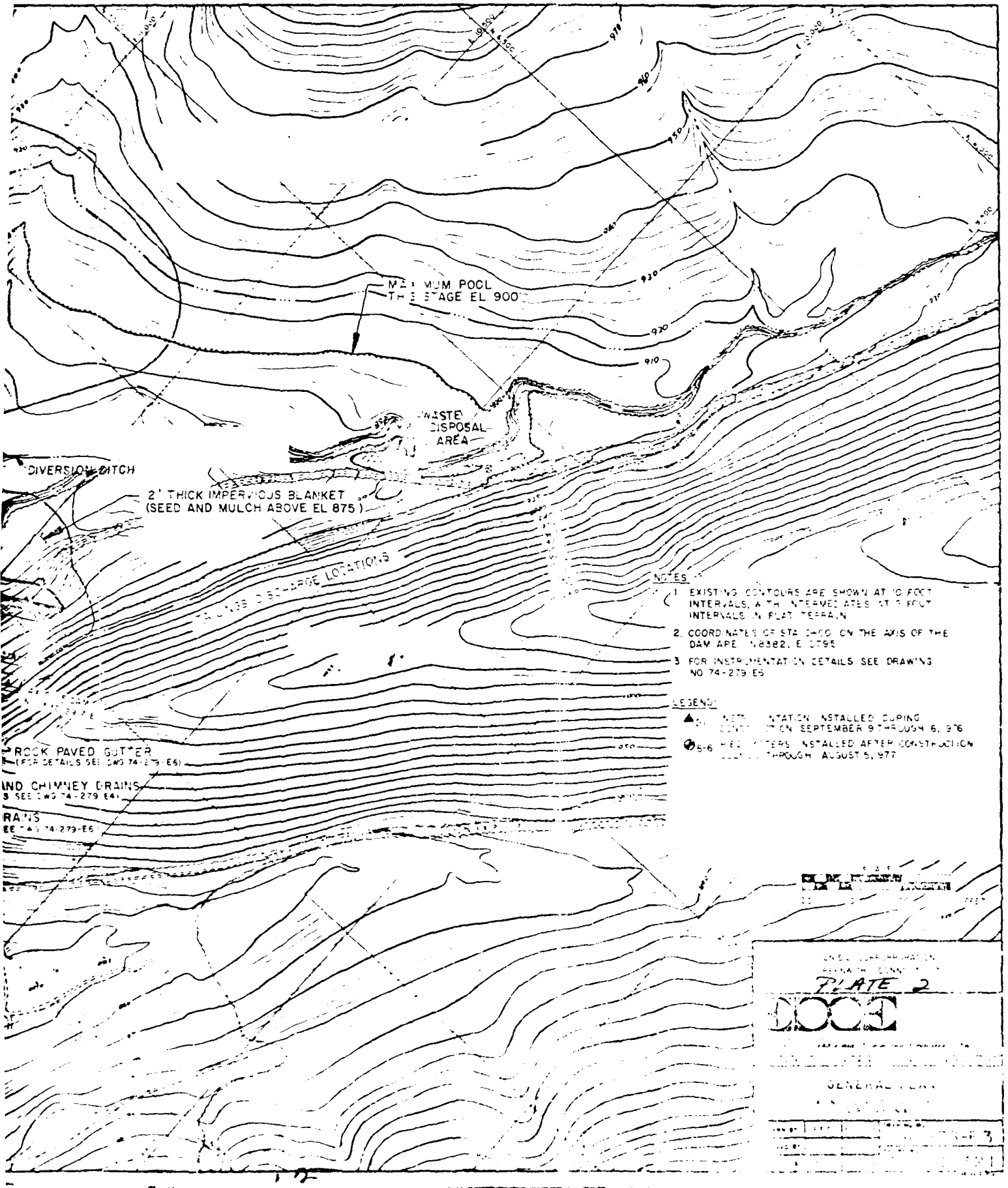
Michael Baker, Jr., Inc.

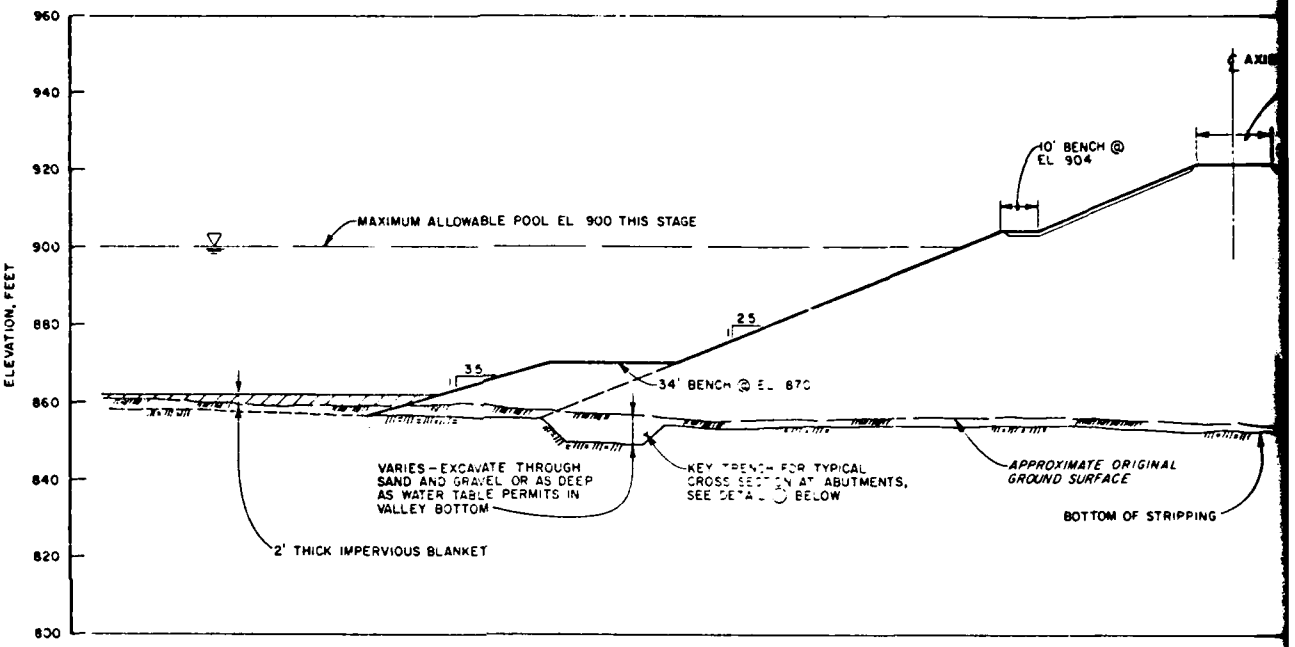
30 October 1980

PLATE 1

DWH 10-80


MAXIMUM POOL EL 915
DURING PROBABLE
MAXIMUM STORM
NATURAL SADDLE
SPILLWAY
BORROW
AREA
KEY TRENCH
DIVERSION DITCH
DECANT RISERS
ROCK PAVED GUTTER
TRENCH AND CHIMNEY DRAINS
TRENCH DRAIN
(TO BE CONSTRUCTED)
A
B

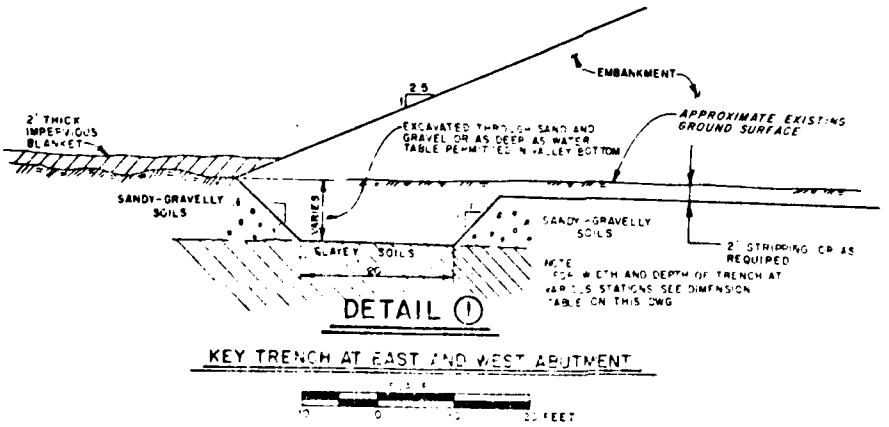

MAXIMUM POOL
THRUST STAGE EL 900
WASTE DISPOSAL AREA
DIVERSION DITCH
2' THICK IMPERVIOUS BLANKET
(SEED AND MULCH ABOVE EL 875)
ROCK PAVED GUTTER
(FOR DETAILS SEE DWG 74-279-E6)
AND CHIMNEY DRAINS
RAINS
NOTES
1. EXISTING CONTOURS ARE SHOWN AT 10 FOOT INTERVALS, ALTERNATES AT 5 FOOT INTERVALS IN FLAT TERRAIN
2. COORDINATES OF STA 0+00 ON THE AXIS OF THE DAM ARE N 8382, E 3795
3. FOR INSTRUMENTATION DETAILS SEE DRAWING NO 74-279-E6
LEGEND
INSTALLED DURING CONSTRUCTION SEPTEMBER 9 THROUGH 6, 976
INSTALLED AFTER CONSTRUCTION THROUGH AUGUST 5, 977
PLATE 2
GENERAL PLAN
3



SECTION A-A
TYPICAL SECTION THRU

(LOOKING WEST)

20 0 20 40 FEET

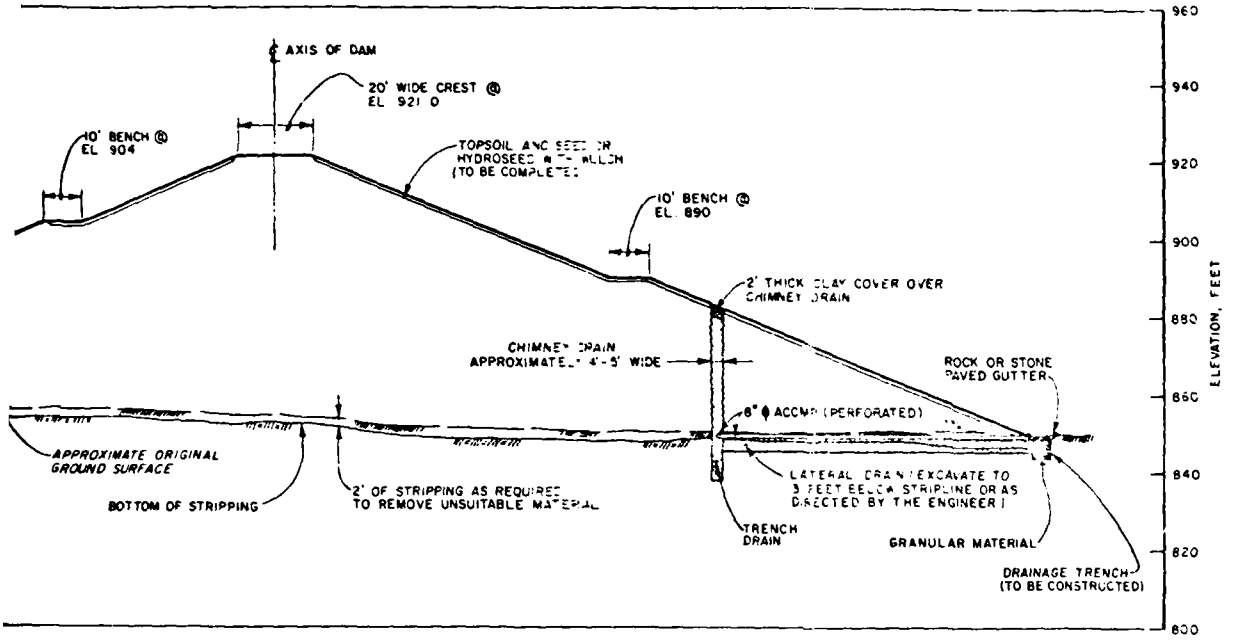


DETAIL (1)

KEY TRENCH AT EAST AND WEST ABUTMENT

0 FEET

KEY TRENCH DIMENSIONS			
DAM STATION	BOTTOM WIDTH (FT)	TOP WIDTH (FT)	DE
0+60	18.0	22	
0+72	17.5	19.5	
0+87	19.5	23.0	
1+05	19.0	22.0	
1+30	19.0	20.0	
1+55	20.0	22.0	
1+71	19.5	23.0	
1+86	19.5	26.0	
3+25	20.0	28.5	
3+50	21.0	29.5	
4+00	21.5	32.8	
4+05	21.5	32.8	
3+85	22.0	33.0	
4+21	22.5	3[illegible]	
4+50	22.0	33.0	



SECTION A-A
SECTION THRU DAM

(LOOKING WEST)

20 0 20 40 FEET

KEY TRENCH DIMENSIONS

STATION	BOTTOM WIDTH (FT)	TOP WIDTH (FT)	DEPTH OF EXCAVATION (FT)
0+60	18.0	22	6.5
0+72	17.5	19.3	6.9
0+87	19.5	23.0	7.7
1+05	19.0	22.0	7.6
1+30	19.0	22.0	6.7
1+55	20.0	22.0	5.0
1+71	19.5	23.0	8.5
1+9[illegible]	19.5	26.0	9.9
3+20	20.0	28.5	4.0
3+92	21.0	29.4	11.3
4+50	21.5	32.8	2.0
4+55	21.5	32.8	3.0
3+85	22.0	30.0	3.0
4+21	22.5	3.0	12.0
4+50	22.0	33.0	12.0

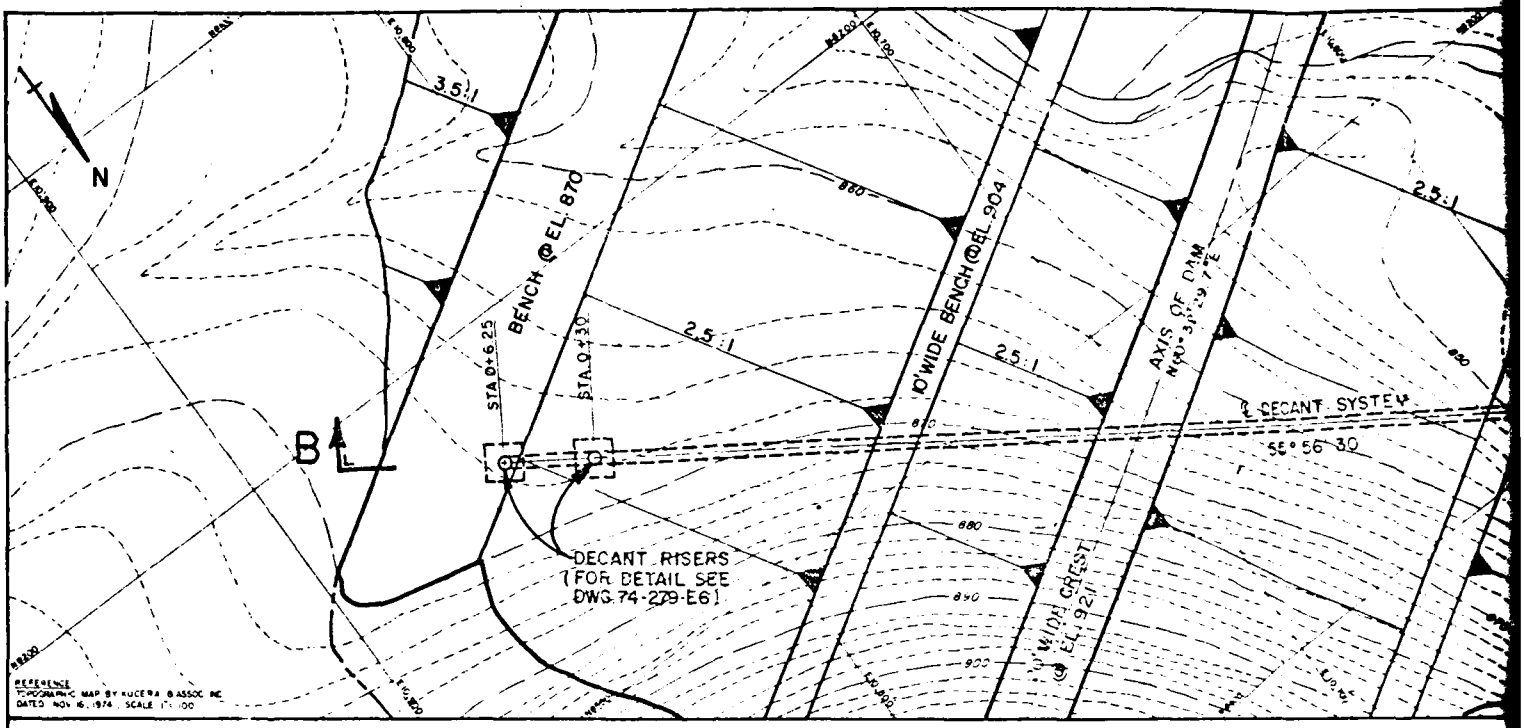
NOTE:
FOR LOCATION OF SECTION, SEE DWG 74-279-E3

PLATE 3

UNISIL CORPORATION
GREENWICH, CONNECTICUT

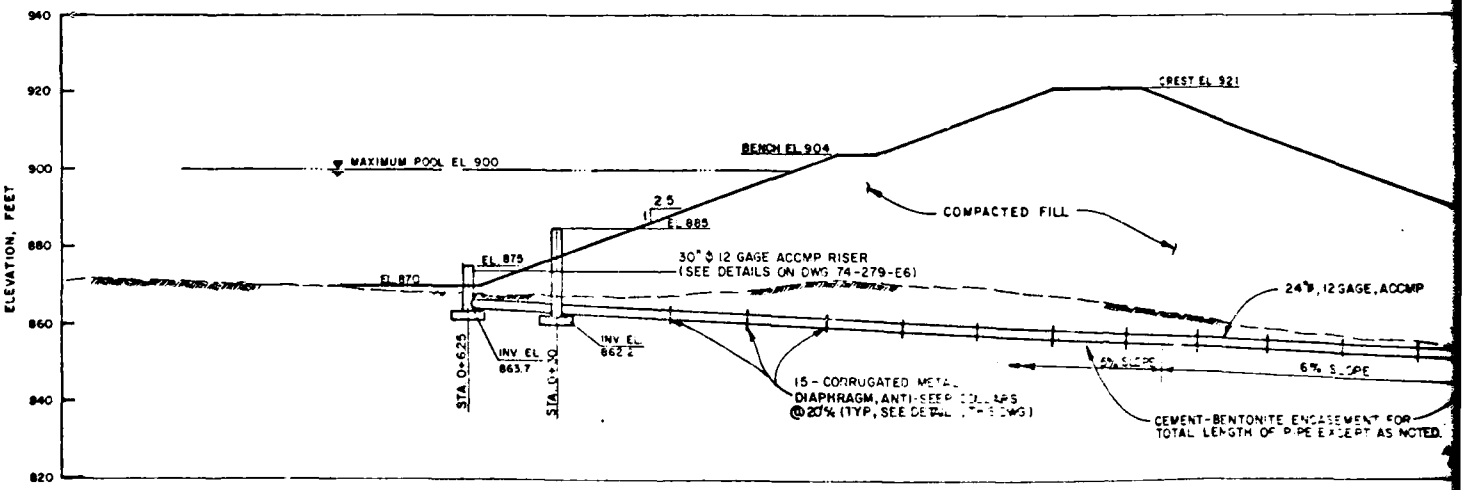
TAILINGS DISPOSAL CAPACITY [illegible]

DRAWN BY	[illegible]	[illegible]	[illegible]
CHECKED BY	[illegible]	[illegible]	[illegible]



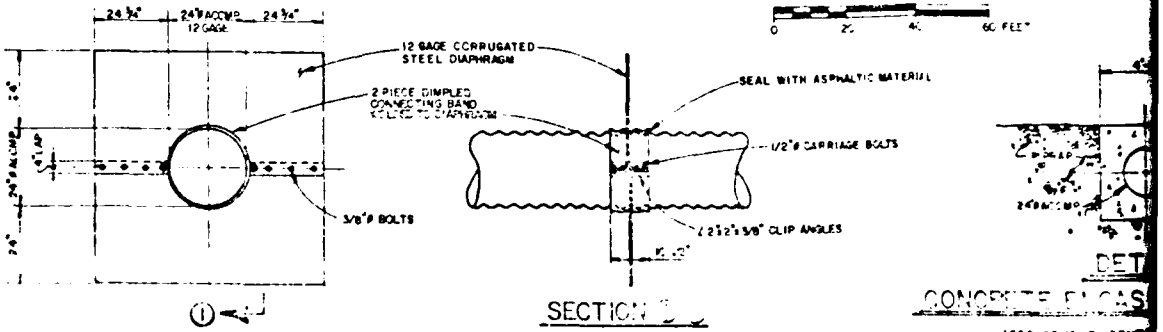
PLAN – DECANT SYSTEM

SCALE
0 20 40 60 FEET

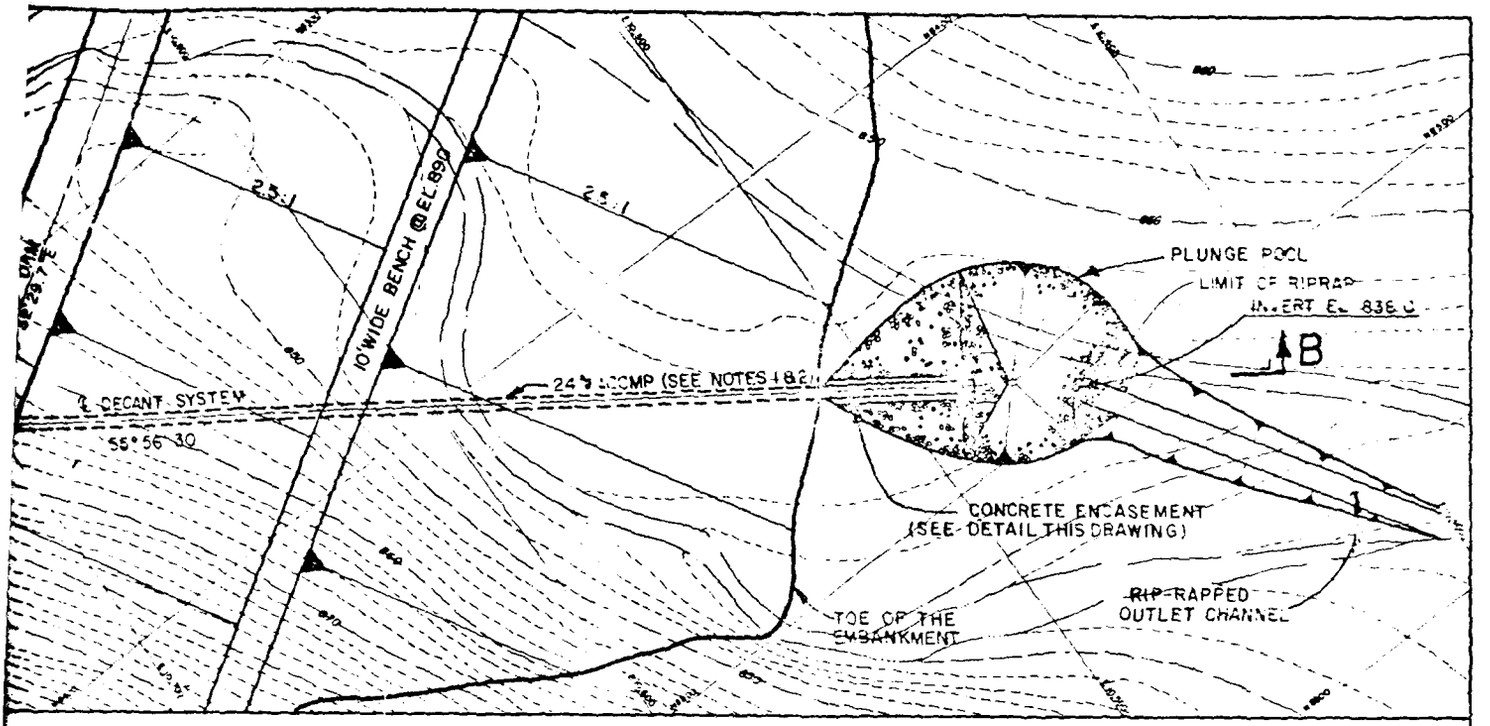


SECTION B-B — PROFILE ALONG ℄ DECANT SY

SCALE
0 20 40 60 FEET

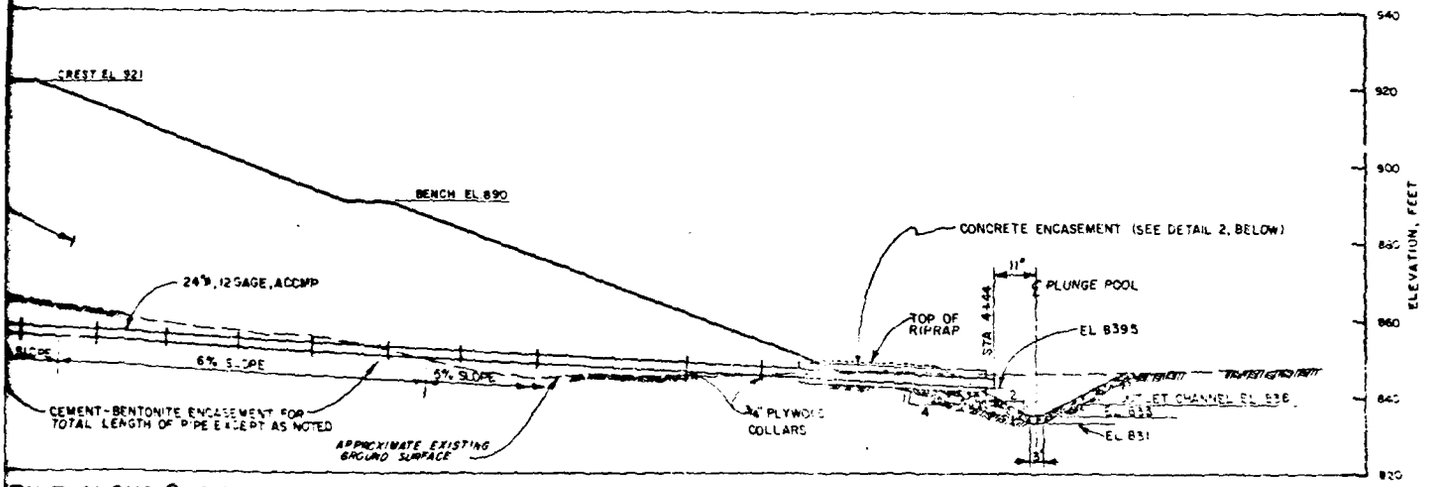


DETAIL (ANTI-SEEP COLLAR DIAPHRAGM



PLAN — DECANT SYSTEM

0 20 40 60 FEET



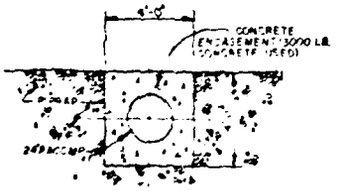
PROFILE ALONG ℄ DECANT SYSTEM

20 40 60 FEET

ASPHALTIC MATERIAL

ARRIAGE BOLTS

NDLES



DETAIL 2

CONCRETE ENCASEMENT AT OUTLET

(FOR CEMENT-BENTONITE ENCASEMENT OF PIPE, SEE DETAIL ON DRAWING 74-279-E6)

NOTES

1. 24"ϕ ACCMP [illegible] WELDED SEAM PIPE AS MANUFACTURED BY ARMCO STEEL CO.
2. PIPES ARE CONNECTED WITH 12" WIDE BANDS WITH NEOPRENE RING GASKETS.
3. RISER AT EL [illegible] WILL BE PLUGGED WITH CONCRETE WHEN TAILINGS LEVEL REACHES EL [illegible] (NOT IN THIS CONTRACT).
4. [illegible] THIS CONTRACT. THE DECANT SHALL NOT BE USED FOR POOL LEVELS GREATER THAN EL 900 OR FOR DAM CREST LEVELS GREATER THAN EL 921.

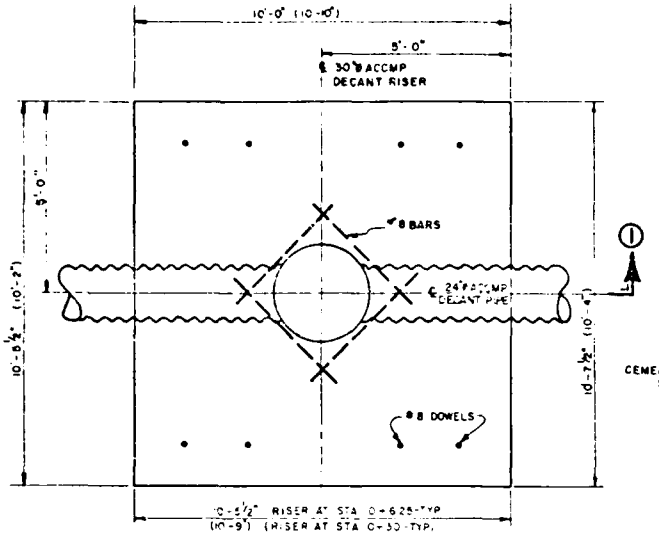
PLATE 4

UNISIL CORPORATION
GREENWICH, CONNECTICUT

PLAN AND PROFILE DECANT SYSTEM

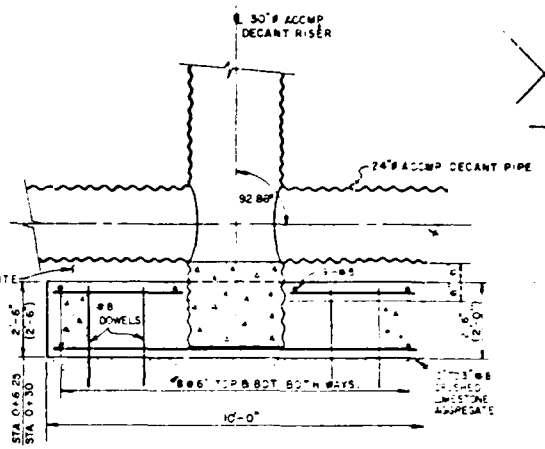
TAILINGS DISPOSAL DAM AND FACILITIES

74-279-E5



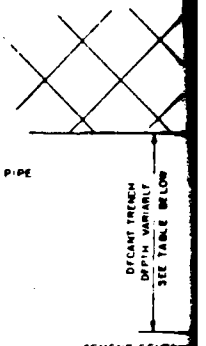
PLAN - DECANT RISER (TYP)

SCALE 1/2 = 1'-0"



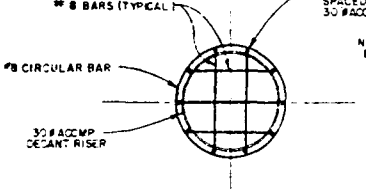
SECTION ①-①

SCALE 1/2 = 1'-0"

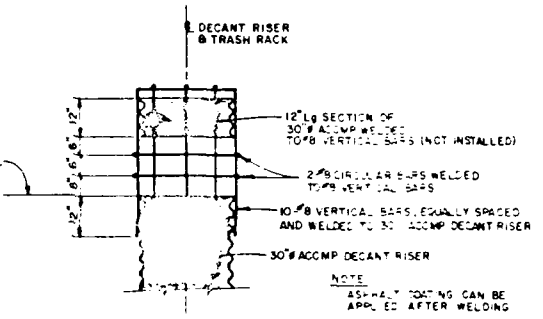


DETAIL -

DEC	
STATION	
+8.	
2+00	
2+20	
2+40	
2+60	



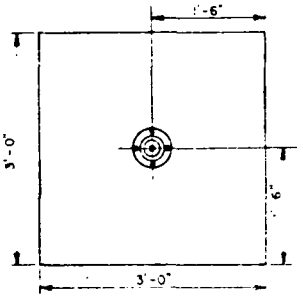
PLAN



ELEVATION

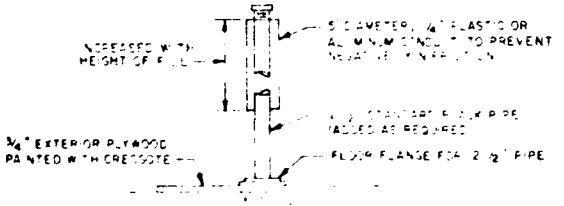
DETAIL- DECANT RISER TRASH RACK

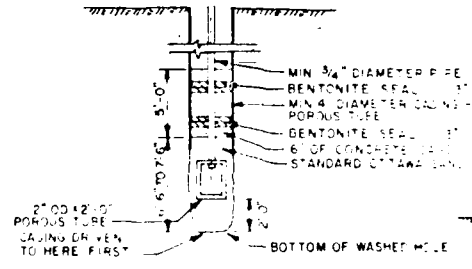
SCALE 1/2=1'-0"



TOP VIEW

N.T.S.



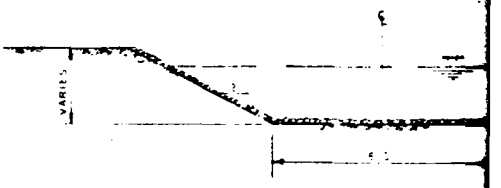


PIEZOMETER DETAILS

N.T.S.

SETTLEMENT PLATE DETAILS

N.T.S.

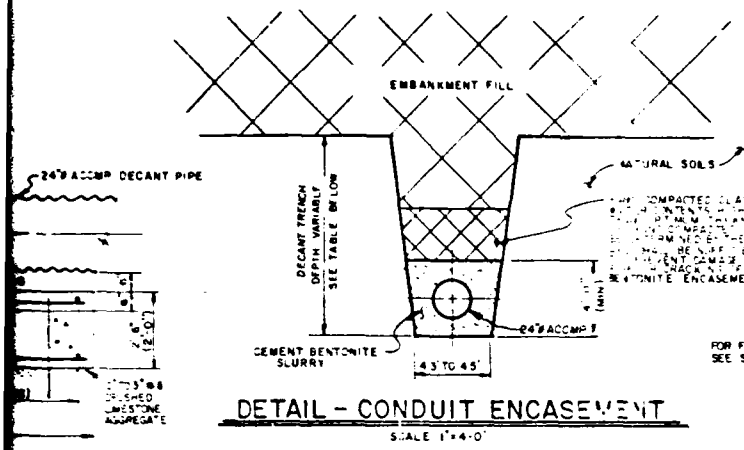


SECTION 2-2

OUTLET CHANN

SCALE 1/2" = 1'-0"

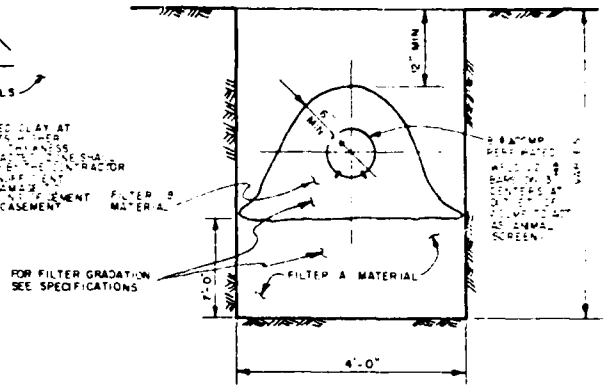
INSTRUMENTATION DETAILS



DETAIL - CONDUIT ENCASEMENT

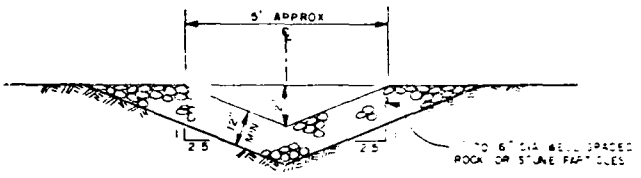
SCALE 1"=4'-0"

DECANT TRENCH EXCAVATION			
STATION	DEPTH	STATION	DEPTH
1+80	7.3'	2+80	7.3'
2+00	7.7'	3+00	7.3'
2+20	8.3'	3+20	7.7'
2+40	9.1'	3+40	8.3'
2+60	9.0'		



TYPICAL DETAIL GRANULAR TRENCH DRAIN AND LATERAL DRAIN

SCALE 1" = 1'-0"

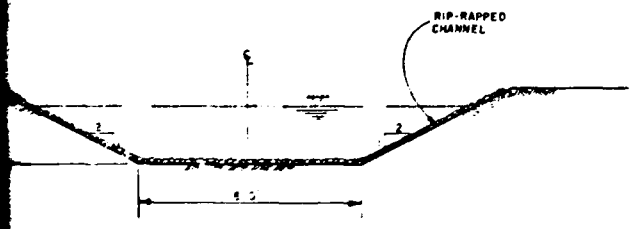


ROCK PAVED GUTTER

SCALE 1/2" = 1'-0"

NOTES:

1. CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH OF 4000 PSI (f'c) AT THE END OF 28 DAYS
2. REINFORCING STEEL SHALL BE OF GRADE 40 AND CONFORM TO ASTM A615
3. REINFORCING STEEL SHALL BE DETAILED IN ACCORDANCE WITH THE BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE, ACI 318-71



SECTION 2-2 OUTLET CHANNEL

SCALE 1/2" = 1'-0"

GREENWICH, CONNECTICUT

TAILINGS DISPOSAL DAM AND FACILITIES

DRAWN BY

CHECKED BY

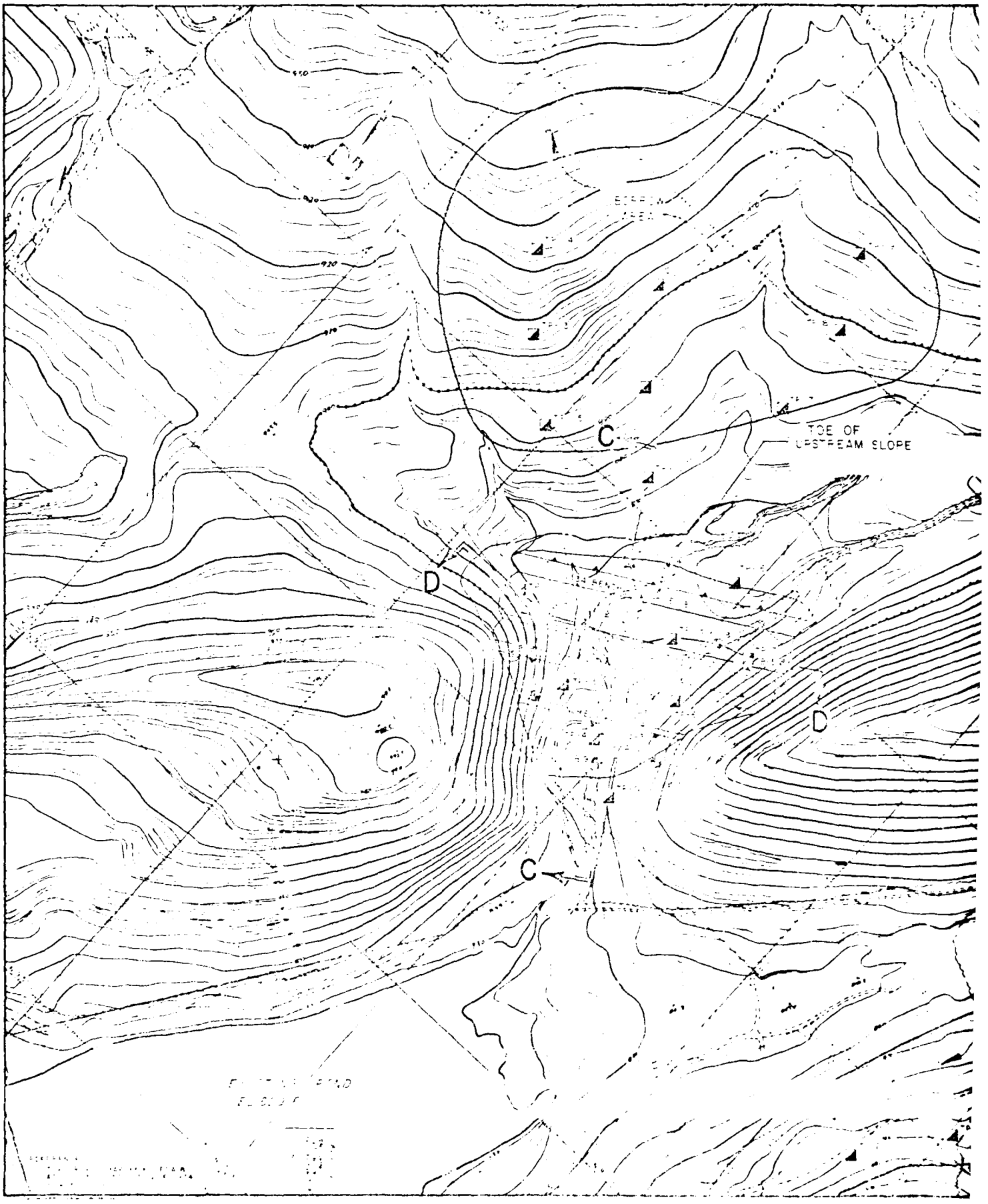
APPROVED BY

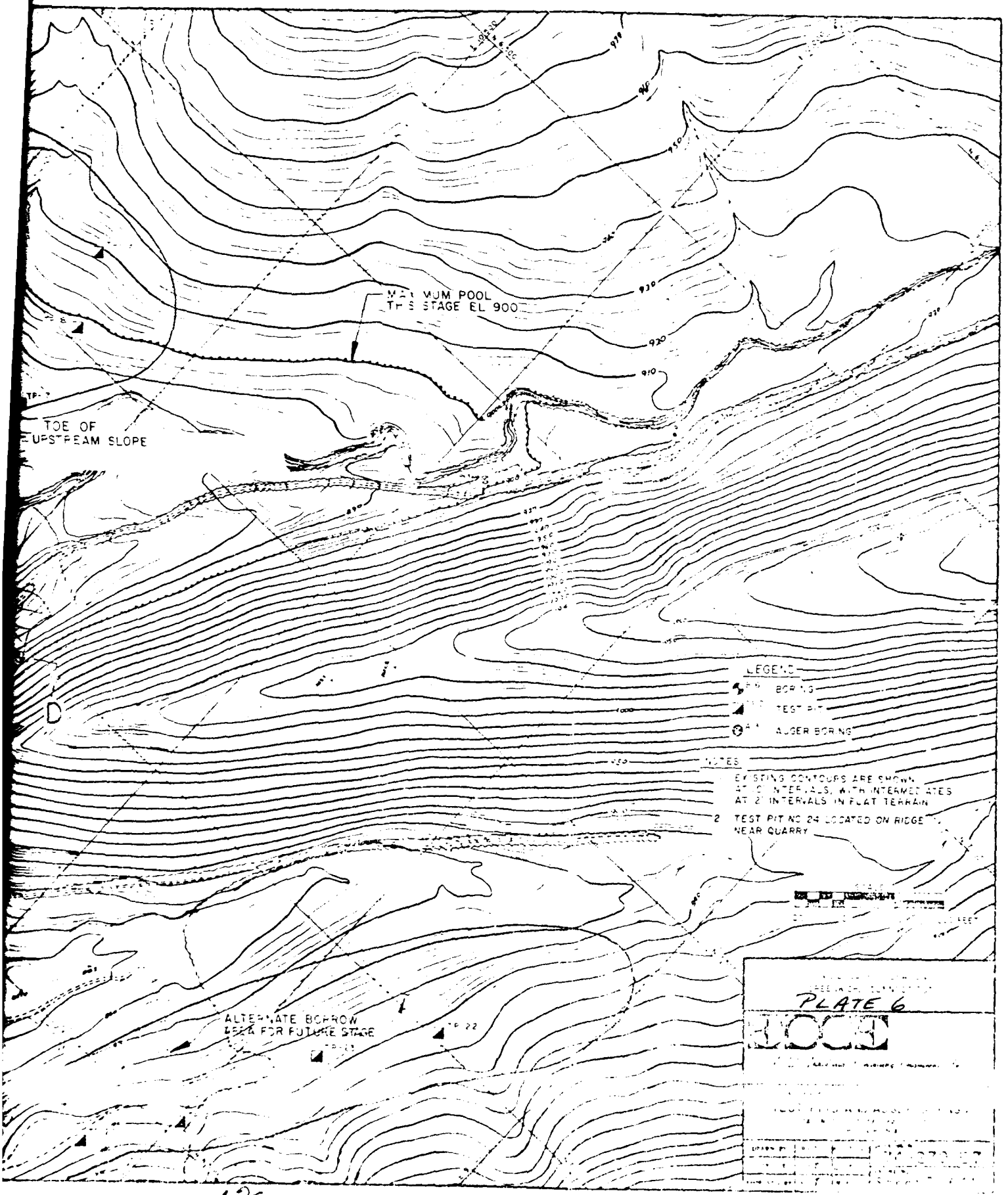
74-279-E6

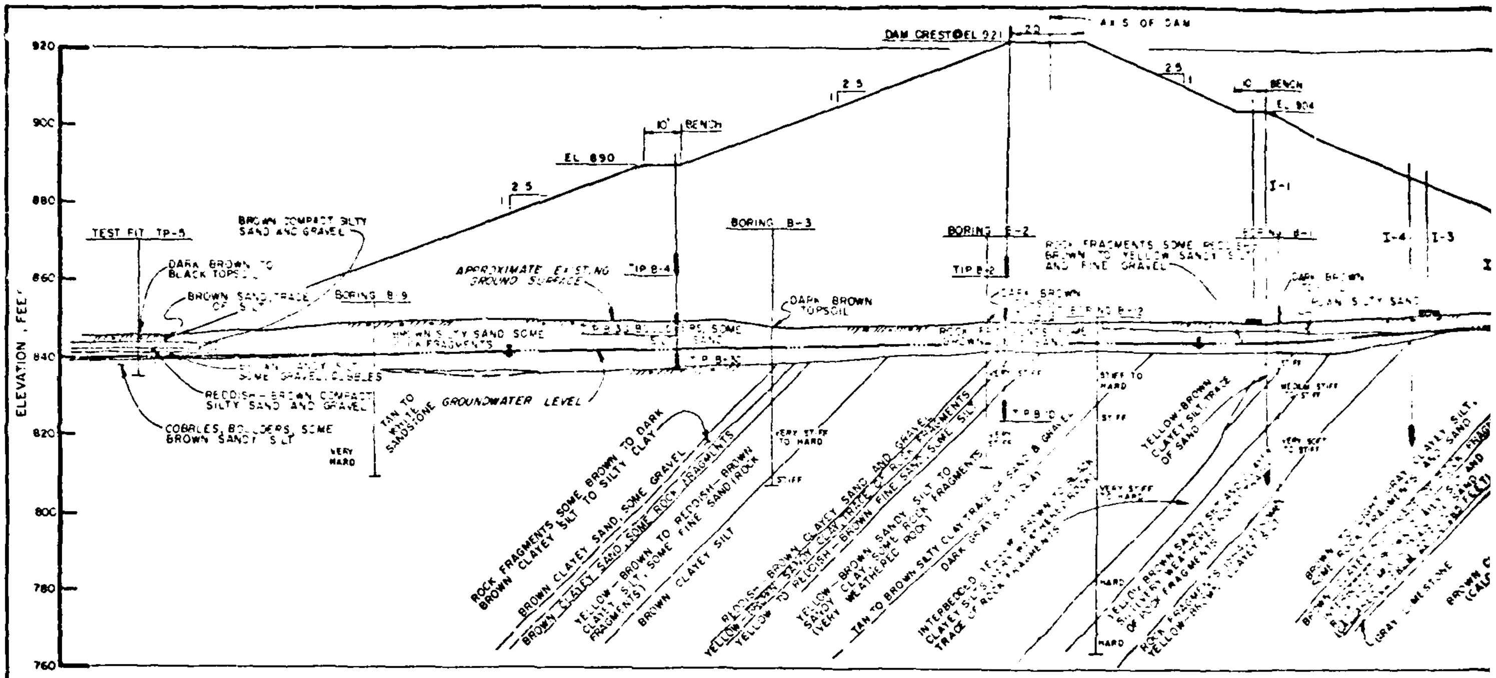
SHEET 5 OF 21

12

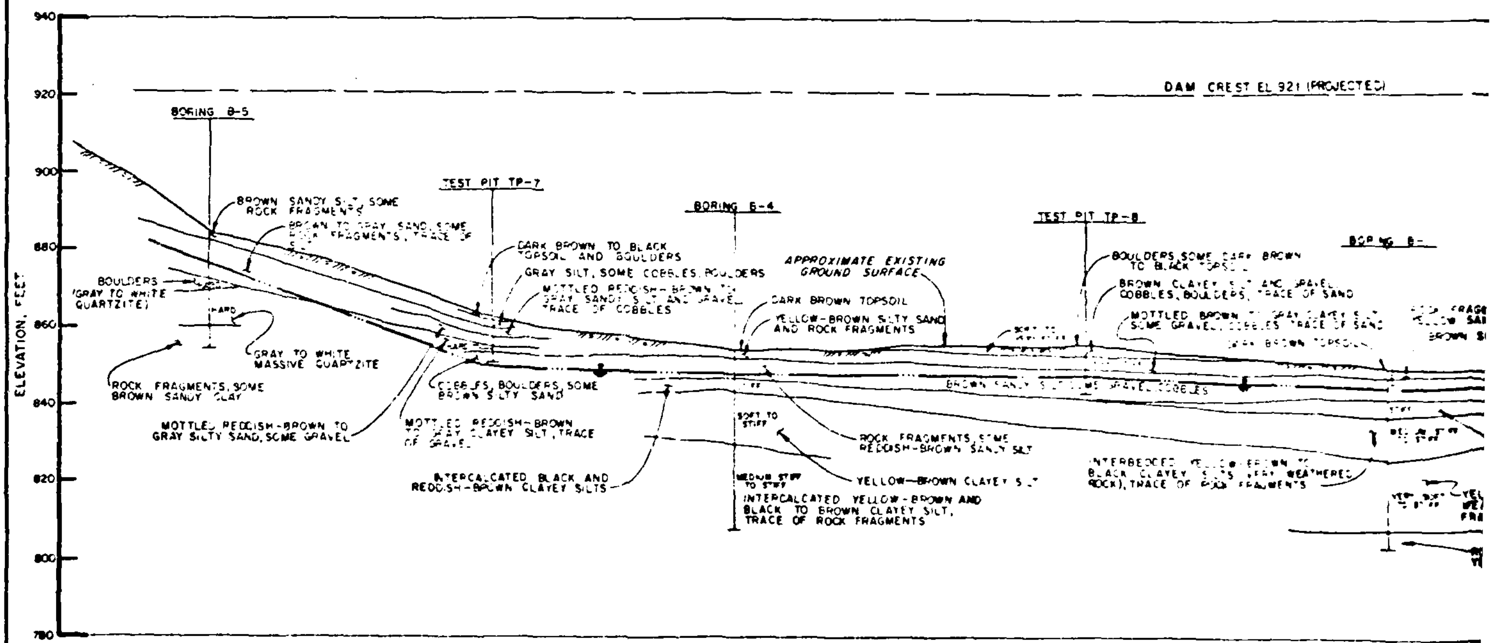
PLATE 5


C
TOE OF
UPSTREAM SLOPE
D
D
C


MAXIMUM POOL
TEST STAGE EL 900
TOE OF
UPSTREAM SLOPE
ALTERNATE BORROW
AREA FOR FUTURE STAGE
LEGEND
BORING
TEST PIT
AUGER BORING
NOTES
EXISTING CONTOURS ARE SHOWN
AT 5' INTERVALS, WITH INTERMEDIATES
AT 2' INTERVALS IN FLAT TERRAIN
2 TEST PIT NO 24 LOCATED ON RIDGE
NEAR QUARRY
PLATE 6



SECTION C-C



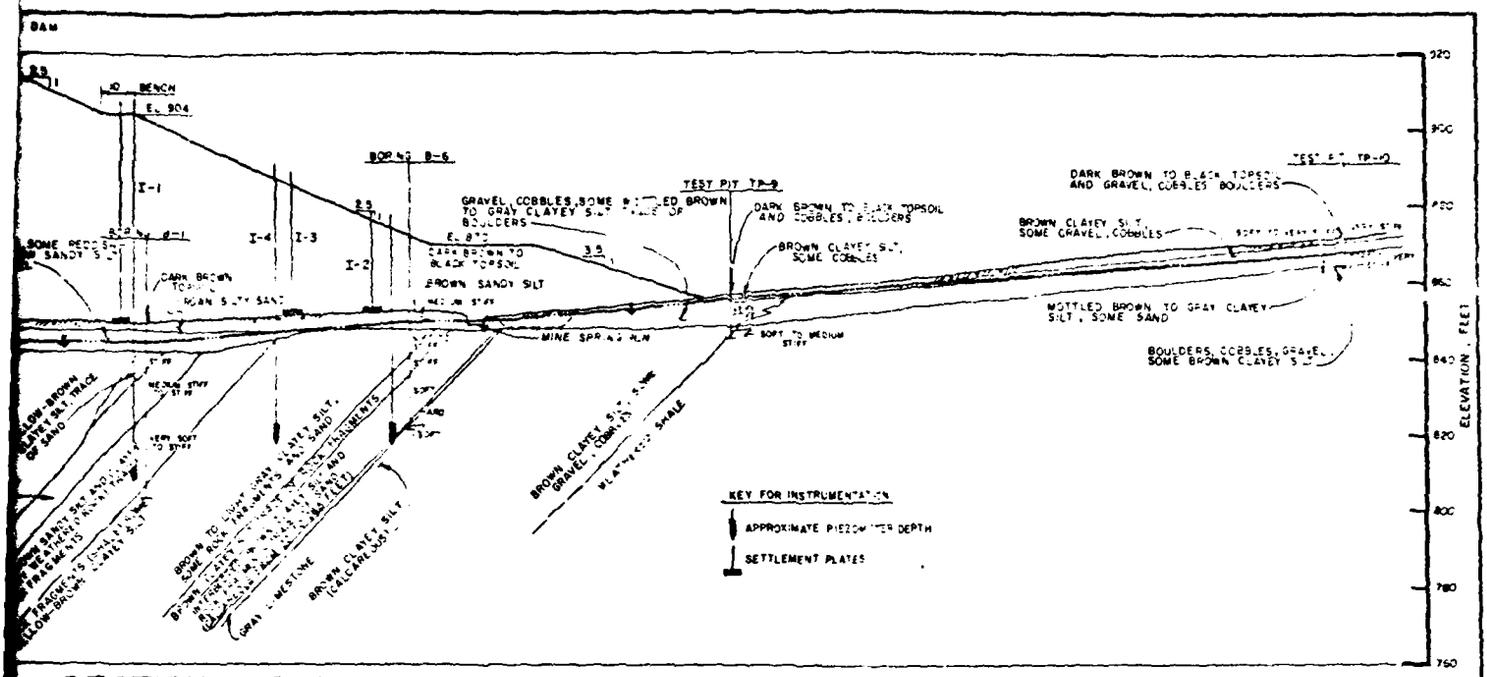
SECTION D-D

NOTE

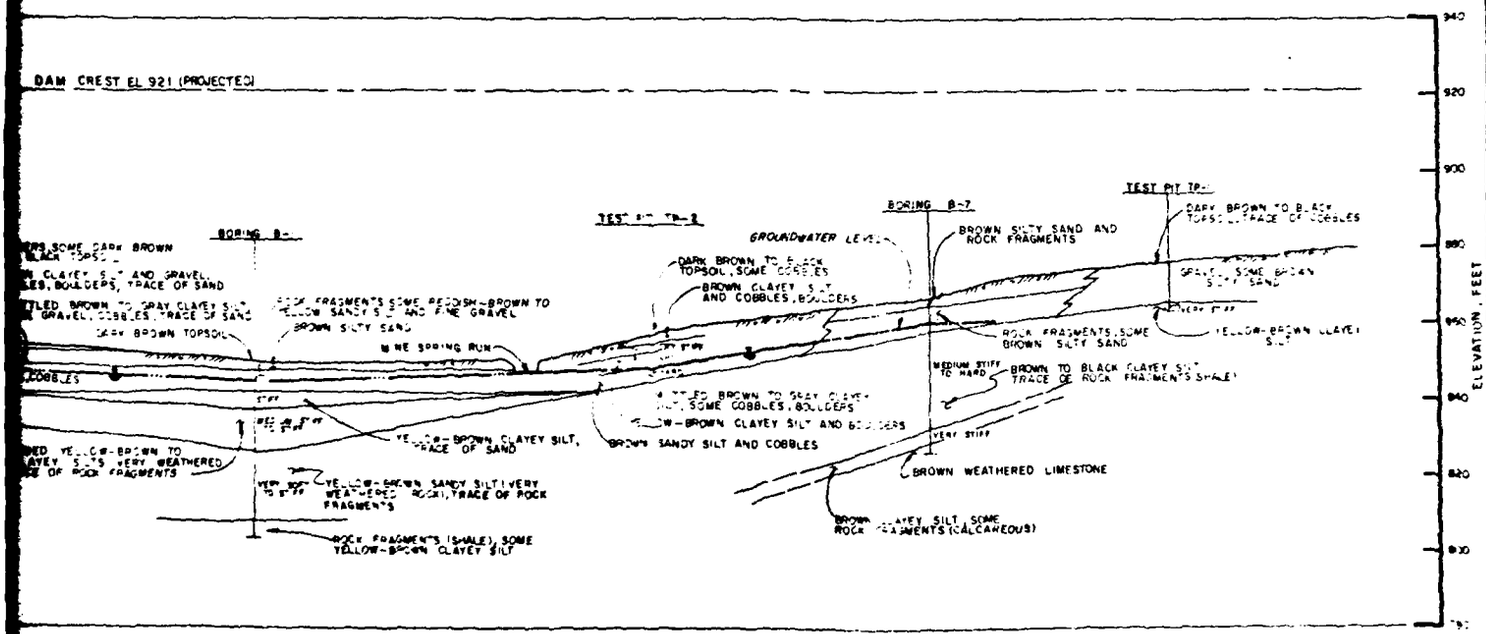
THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS.

[illegible] AND INTERPOLATED BETWEEN THE TEST BORINGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE LOCATION OF THE TEST BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED.

REVISIONS
REVISED EDITION
RBP



SECTION C-C (LOOKING NORTHEAST)



SECTION D-D (LOOKING NORTHWEST)

LOGS AND RELATED INFORMATION
SUBSURFACE CONDITIONS ONLY AT
E LOCATIONS AND DATES INDICATED
TIONS AND WATER LEVELS AT
ATIONS MAY DIFFER FROM CONDITIONS
AT THESE BORING LOCATIONS ALSO
E OF TIME MAY RESULT IN A
TIME CONDITIONS AT THESE
CATIONS

[illegible] DATA
[illegible]
OLATED BETWEEN THE TEST BORINGS
ON ACTUAL SUBSURFACE CONDITIONS
AT THE LOCATION OF THE TEST BORINGS
SSIBLE THAT SUBSURFACE CONDITIONS
HE TEST BORINGS MAY VARY FROM THOSE

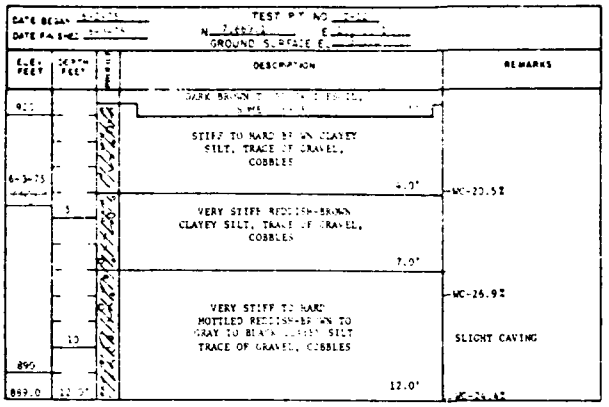
NOTES

1. ALL ELEVATIONS ARE FEET ABOVE MEAN SEA LEVEL, USGS DATUM
2. FOR PLAN AND LOCATION OF SECTIONS, BORINGS AND TEST PITS SEE DWG 74-279-ET
3. FOR DETAILED DESCRIPTION OF BORINGS AND TEST [illegible] DWGS 74-279-E12 THROUGH 74-279-E16, ALSO E [illegible]
4. [illegible]
5. THE POSITION OF THE WATER TABLE SHOWN WAS DERIVED FROM [illegible]

0 20 40 FEET

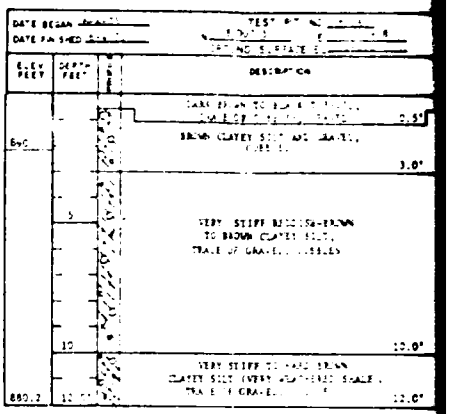
UNSIL CORPORATION
GREENWICH, CONNECTICUT
PLATE 7

SECTIONS C-C AND D-D



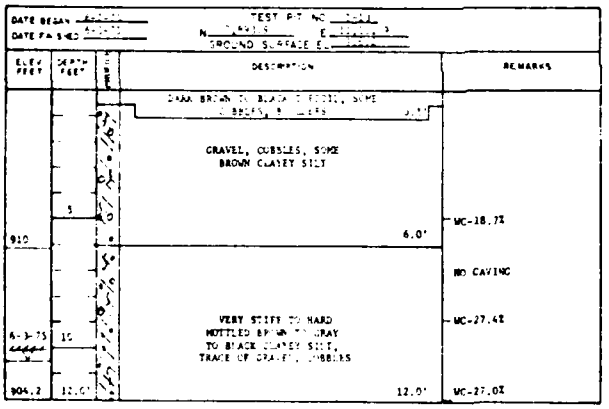
BOTTOM OF TEST PIT - 12.0'

LIMIT OF BACKHOE



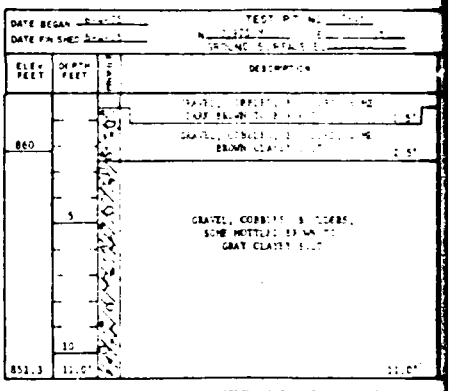
BOTTOM OF TEST PIT - 12.0'

LIMIT OF BACKHOE



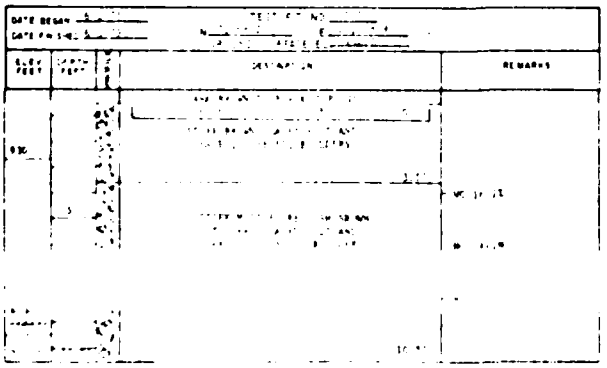
BOTTOM OF TEST PIT - 12.0'

LIMIT OF BACKHOE



BOTTOM OF TEST PIT - 11.0'

LIMIT OF BACKHOE



TEST PIT NO. T-12
N 8,307.5 E [illegible]
GROUND SURFACE E [illegible]

DESCRIPTION	REMARKS
DARK BROWN TO BLACK TOPSOIL, TRACE OF COBBLES, TRACE OF GRAVEL 0.5'	
BROWN CLAYEY SILT AND GRAVEL, COBBLES 3.0'	
VERY STIFF REDDISH-BROWN TO BROWN CLAYEY SILT, TRACE OF GRAVEL, COBBLES 10.0'	MC-28.6% NO SEEPAGE AFTER 30 MINUTES Bag Sample MC-39.9% P.I.-39.6 L.L.-71.6 NO CAVING
VERY STIFF TO HARD BROWN CLAYEY SILT (VERY WEATHERED SHALE), TRACE OF GRAVEL, COBBLES 11.0'	MC-38.5%

BOTTOM OF TEST PIT - 11.0'
LIMIT OF BACKHOE

TEST PIT NO. T-13
N 7,375.9 E [illegible]
GROUND SURFACE E [illegible]

DESCRIPTION	REMARKS
TRACE, COBBLES, [illegible] DARK BROWN TO BLACK [illegible] 0.5'	
GRAVEL, COBBLES, [illegible] BROWN CLAYEY SILT 2.5'	
GRAVEL, COBBLES, BOULDERS, SOME MOTTLED BROWN TO GRAY CLAYEY SILT 11.0'	SLIGHT CAVING SEEPAGE @ 6'-AFTER 30 MINUTES

BOTTOM OF TEST PIT - 11.0'
LIMIT OF BACKHOE

NOTES

1 FOR PLAN AND LOCATION OF TEST PITS, SEE DWG 74-279-E7

2 FOR GENERAL NOTES AND LEGENDS, SEE DWG 74-279-E13

3 THE TEST PIT LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE TEST PIT LOCATIONS ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE TEST PIT LOCATIONS.

4 SUBSURFACE INFORMATION SHOWN ON THIS DRAWING WAS OBTAINED SOLELY FOR USE IN ESTABLISHING DESIGN CONTROLS FOR THE PROJECT THE ACCURACY OF THIS INFORMATION IS NOT GUARANTEED AND IT IS NOT TO BE CONSTRUED AS PART OF THE PLANS GOVERNING CONSTRUCTION OF THE PROJECT

PLATE 8

UNISIL CORPORATION
GREENWICH, CONNECTICUT

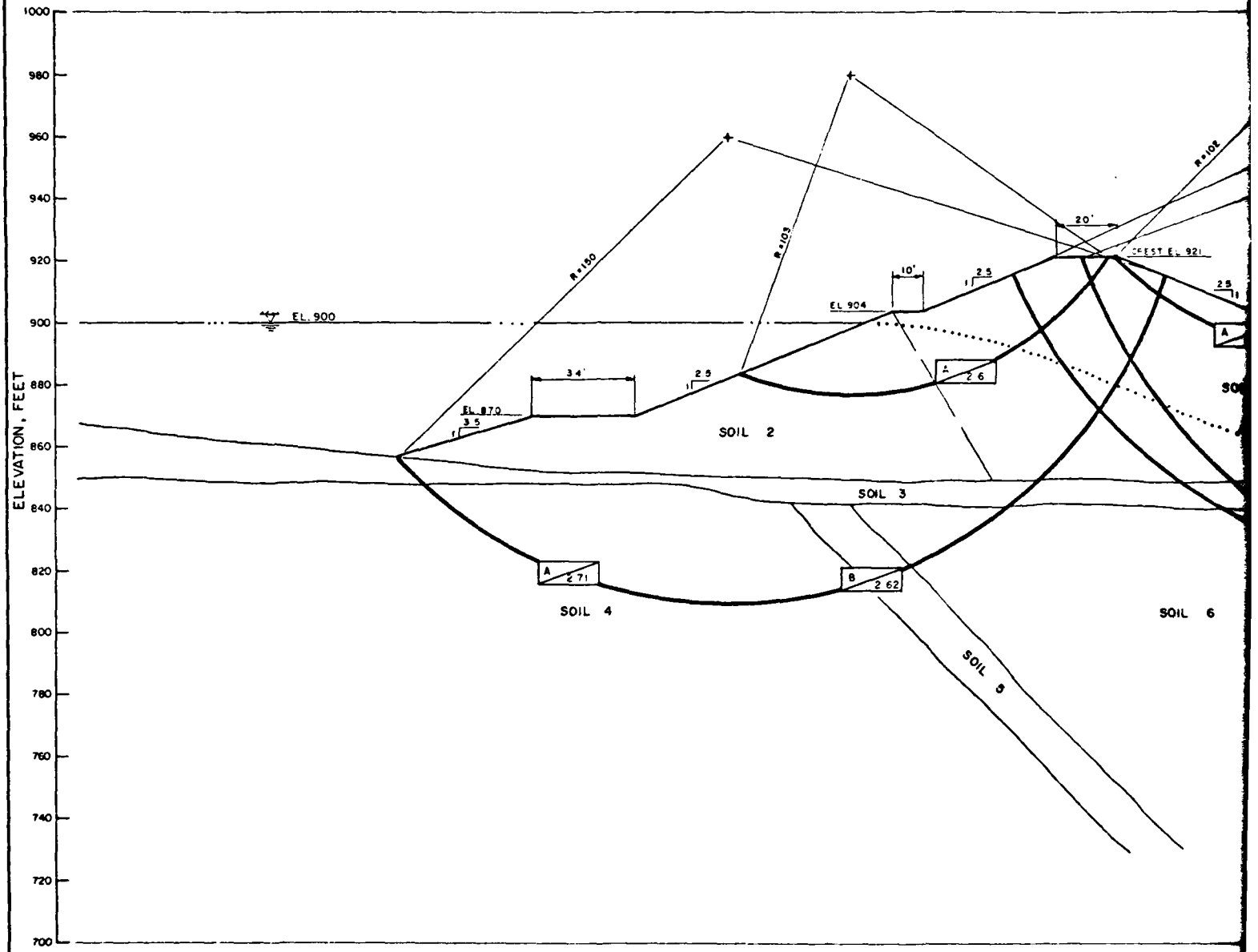
TOCK

TEST PIT LOGS T-12 THROUGH T-16

TAILINGS DISPOSAL DAM AND FACILITIES

DRAWN BY	[illegible]	7-23-79	DRAWING NO. 74-279-E 8
CHECKED BY	[illegible]	[illegible]	
[illegible] BY	[illegible]		SCALE [illegible]

12



GENERALIZED SOIL DESCRIPTION

SOIL NO	SOIL DESCRIPTION
1	CLAYEY SILT FILL [illegible]
2	CLAYEY [illegible]
3	[illegible]
4	CLAYEY [illegible]
5	[illegible]
6	CLAYEY SAND [illegible]

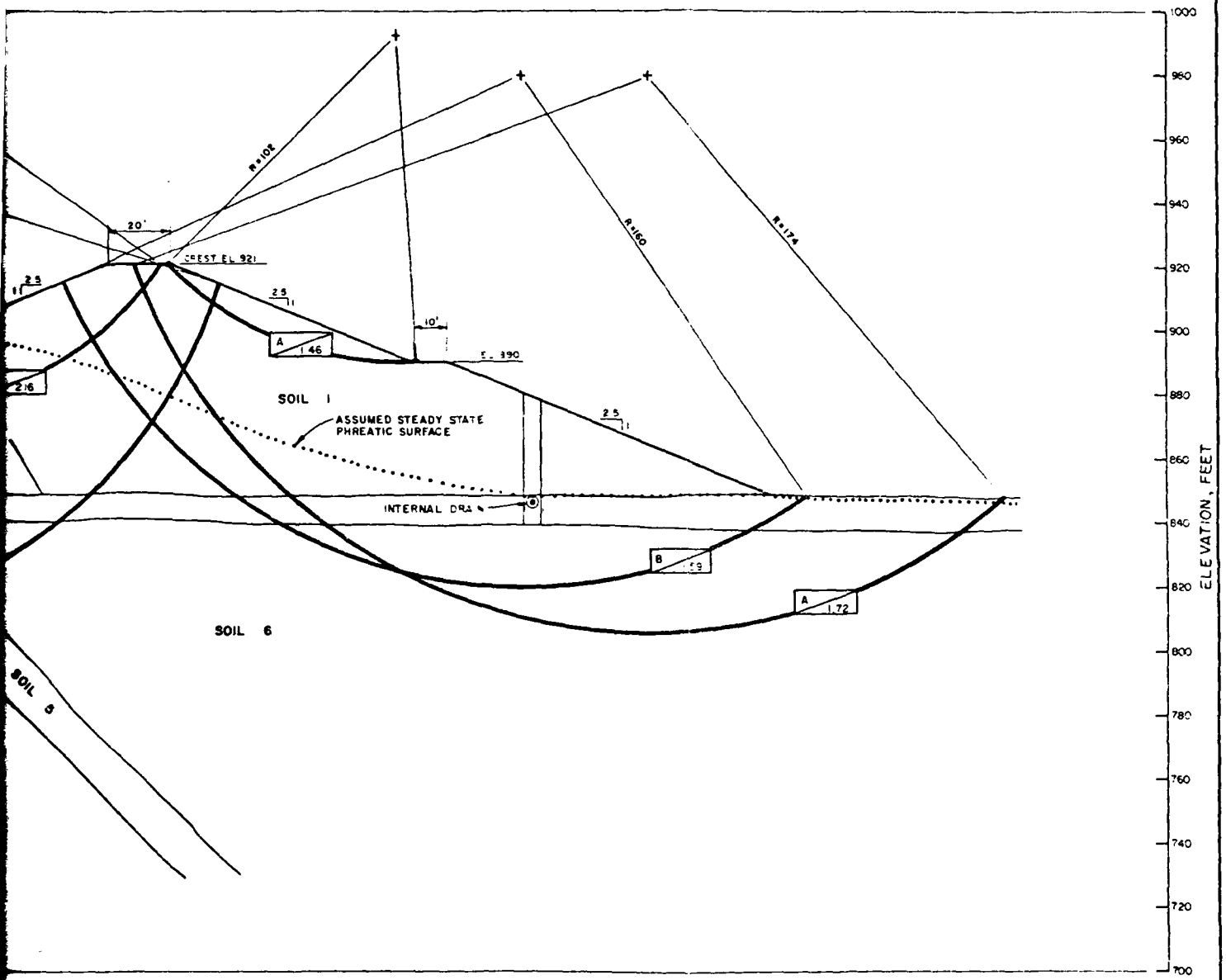
SOIL PARAMETERS USED IN STABILITY ANALYSIS

SOIL NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	120	400	20	[illegible]	0
3	120	0	34	9000	0
4	120	200	25	1800	0
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	120	0	30	1800	0

NOTES

1. LONG TERM STABILITY ANALYSIS IS USED [illegible] CONSTRUCTION
2. SHORT TERM STABILITY ANALYSIS IS USED [illegible] CONSTRUCTION
3. COMPUTED FACTOR OF SAFETY INDICATED
   A/B / FS — A = LONG TERM STABILITY
   B = SHORT TERM STABILITY
   FS = FACTOR OF SAFETY
4. STABILITY ANALYSES WERE PERFORMED [illegible] COMPUTERIZED VERSION OF BISHOP'S METHOD
5. [illegible] THE
6. [illegible] THE LABORATORY [illegible] ON DRILL [illegible] AND FROM FIELD INVESTIGATION

REVISIONS
1 REVISED SECTION



NOTES

1. LONG TERM STABILITY ANALYSIS IS USED AFTER CONSTRUCTION
2. SHORT TERM STABILITY ANALYSIS IS USED DURING CONSTRUCTION
3. COMPUTED FACTOR OF SAFETY INDICATED BY
   A or B / FS
   A = LONG TERM STABILITY ANALYSIS
   B = SHORT TERM STABILITY ANALYSIS
   FS = CRITICAL FACTOR OF SAFETY
4. STABILITY ANALYSES WERE PERFORMED USING A COMPUTERIZED VERSION OF BISHOPS METHOD OF [illegible]
5. [illegible] THROUGH THE EMBANKMENT [illegible]
6. STRENGTH PARAMETERS WERE DETERMINED FROM THE LABORATORY TESTS SHOWN ON DWG 74-279-E18 AND FROM FIELD INVESTIGATION

SCALE
20 0 20 40 FEET

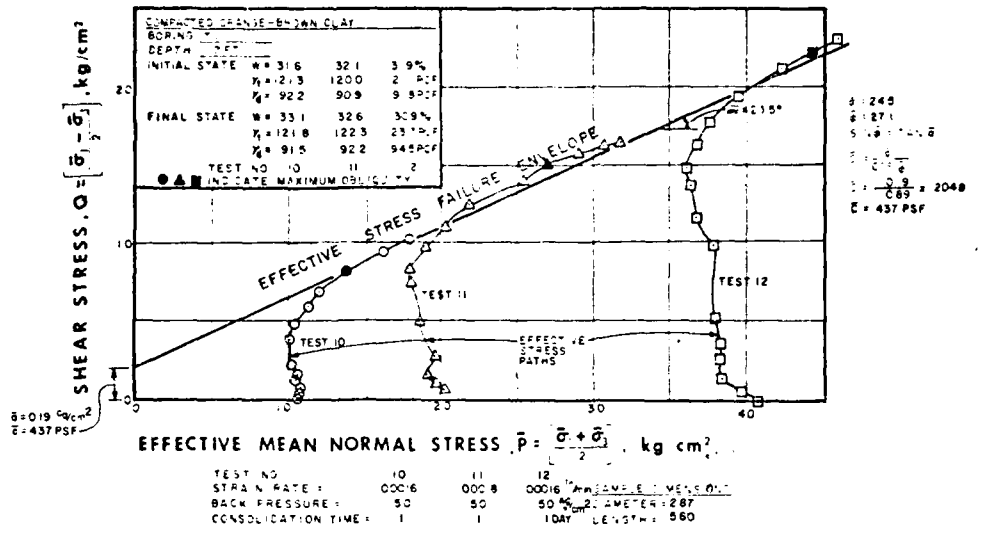
PLATE 9

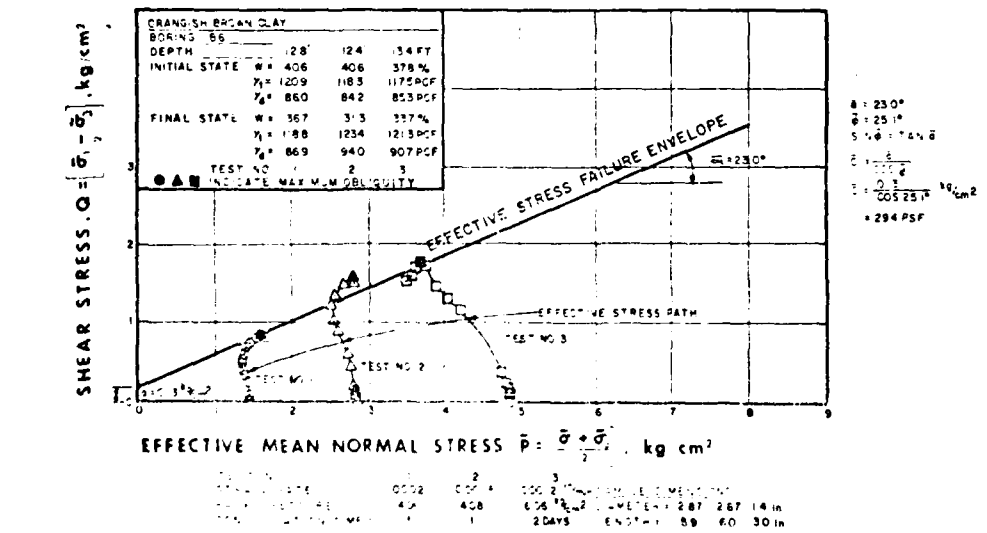
UNITED ILLUMINATING
GREENWICH, CONNECTICUT

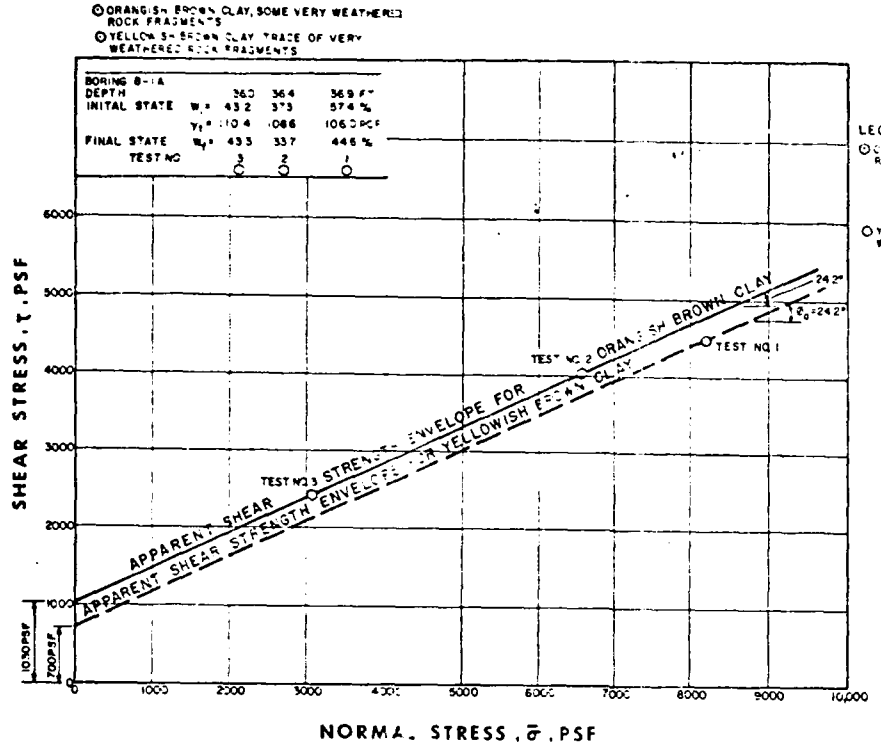
SCS

SLOPE STABILITY [illegible]
TAILINGS [illegible]
SCALE [illegible]

DRAWN BY	[illegible]	[illegible]	74-279-E19
CHECKED BY	[illegible]	[illegible]	[illegible]
APPROVED BY	[illegible]		


COMPACTED GRANGE-BROWN CLAY
BORING
DEPTH
INITIAL STATE
FINAL STATE
TEST NO
INDICATE MAXIMUM OBLIQUITY
EFFECTIVE STRESS FAILURE ENVELOPE
TEST 11
TEST 12
TEST 10
EFFECTIVE STRESS PATHS
SHEAR STRESS, Q = [(σ1 − σ3)/2], kg/cm²
EFFECTIVE MEAN NORMAL STRESS P̄ = [(σ̄1 + σ̄3)/2], kg cm²
TEST NO
STRAIN RATE =
BACK PRESSURE =
CONSOLIDATION TIME =


GRANGE-BROWN CLAY
BORING
DEPTH
INITIAL STATE
FINAL STATE
TEST NO
INDICATE MAXIMUM OBLIQUITY
EFFECTIVE STRESS FAILURE ENVELOPE
EFFECTIVE STRESS PATH
TEST NO 3
TEST NO 2
SHEAR STRESS, Q = [(σ1 − σ3)/2], kg/cm²
EFFECTIVE MEAN NORMAL STRESS P̄ = [(σ̄1 + σ̄3)/2], kg cm²



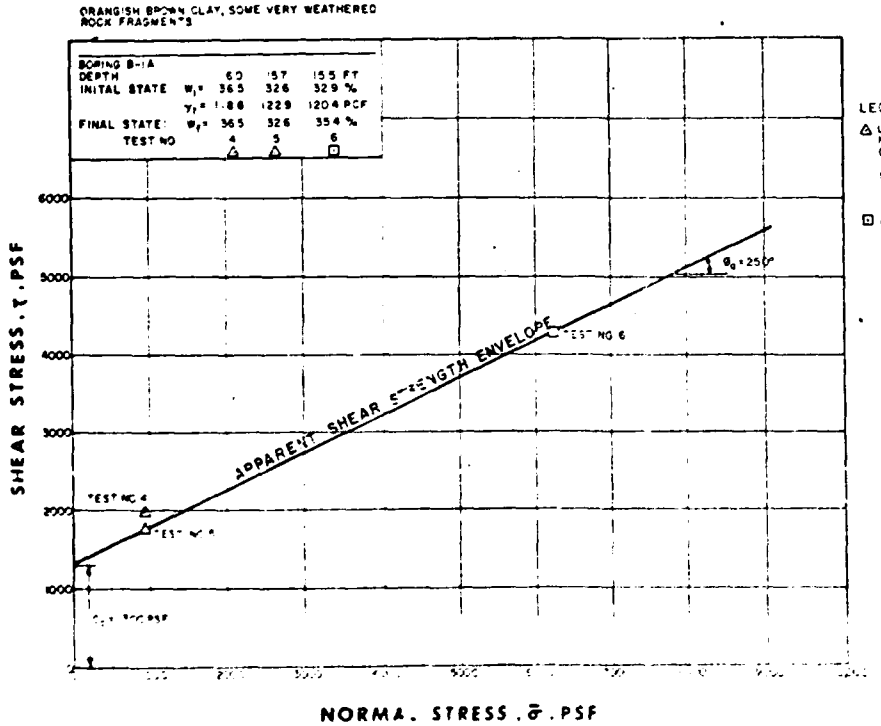


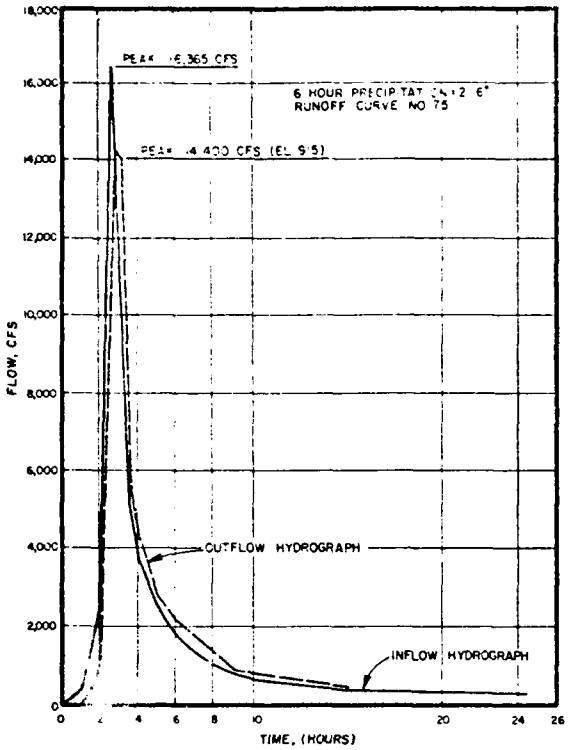
PLATE 10

UNISIL CORPORATION
GREENWICH, CONNECTICUT

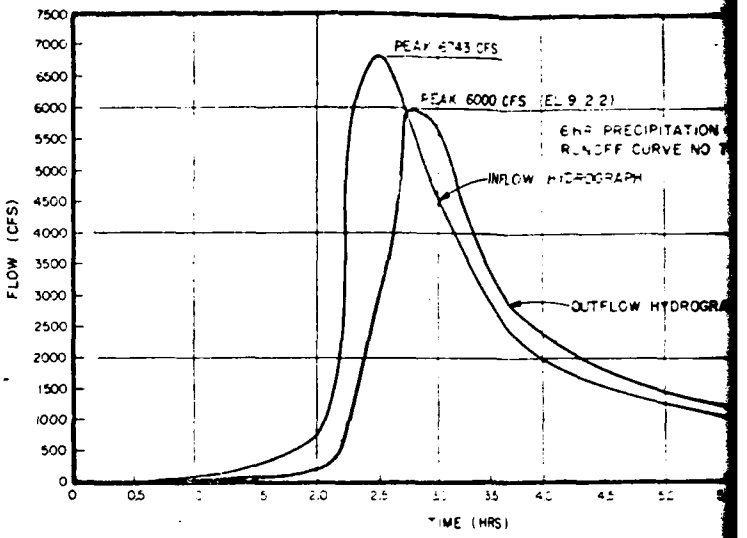
EDGE

SHEAR STRENGTH TESTS
TAILINGS DISPOSAL DAM AND APPURTENANCES

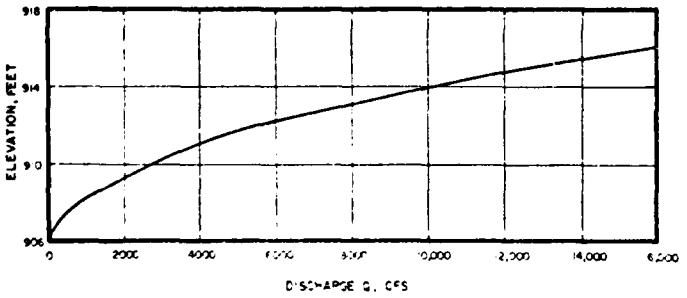
DRAWN BY	M.F.		
CHECKED BY			



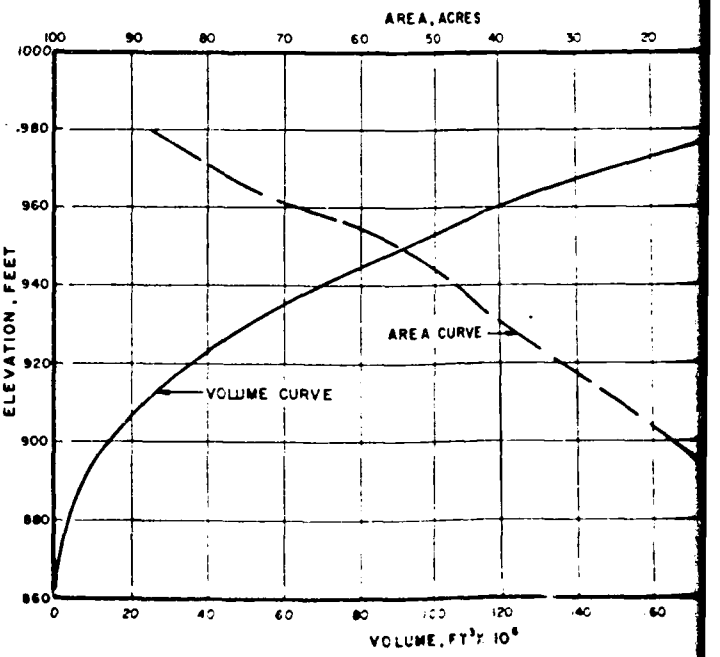
PROBABLE MAXIMUM PRECIPITATION STORM
INFLOW - OUTFLOW HYDROGRAPHS



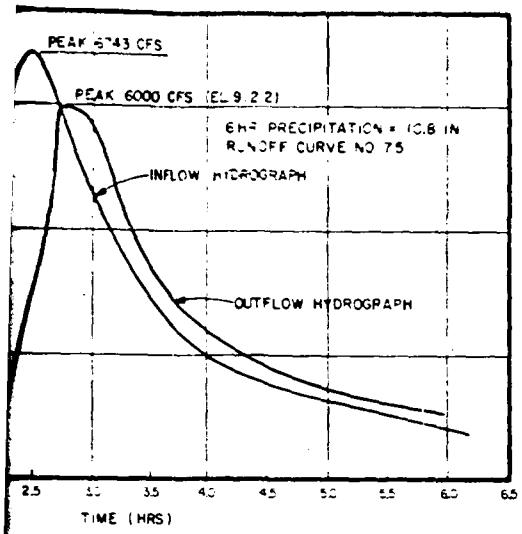
50% PROBABLE MAXIMUM PRECIPITATI
STORM INFLOW - OUTFLOW HYDROGRAPH



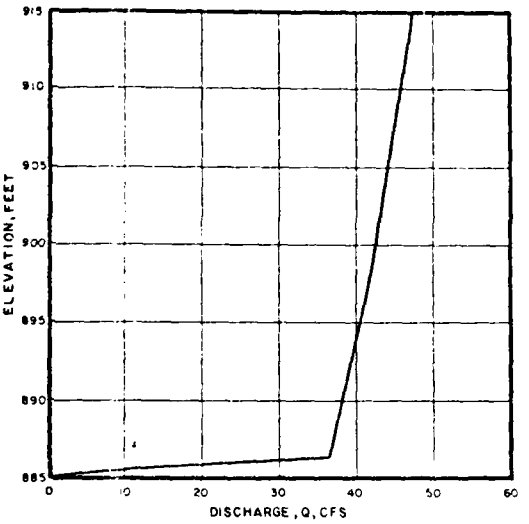
STAGE DISCHARGE RELATIONSHIP
FOR EMERGENCY SPILLWAY



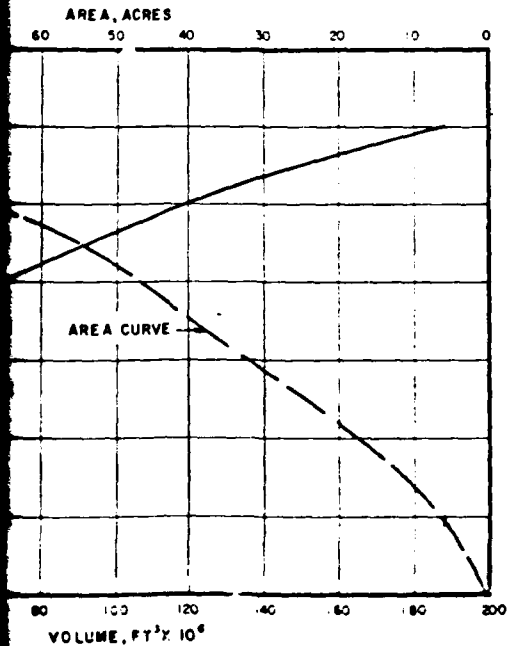
ELEVATION Vs AREA AND VOLUM



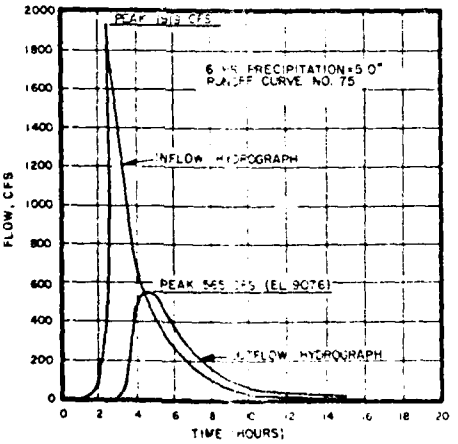
MAXIMUM PRECIPITATION
- OUTFLOW HYDROGRAPHS



STAGE DISCHARGE RELATIONSHIP FOR
DECANT STRUCTURE



Vs AREA AND VOLUME



100 YEAR STORM
INFLOW- OUTFLOW HYDROGRAPH

PLATE 11

UNISIL CORPORATION
GREENWICH, CONNECTICUT

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
Box 280
Beaver, Pa. 15009

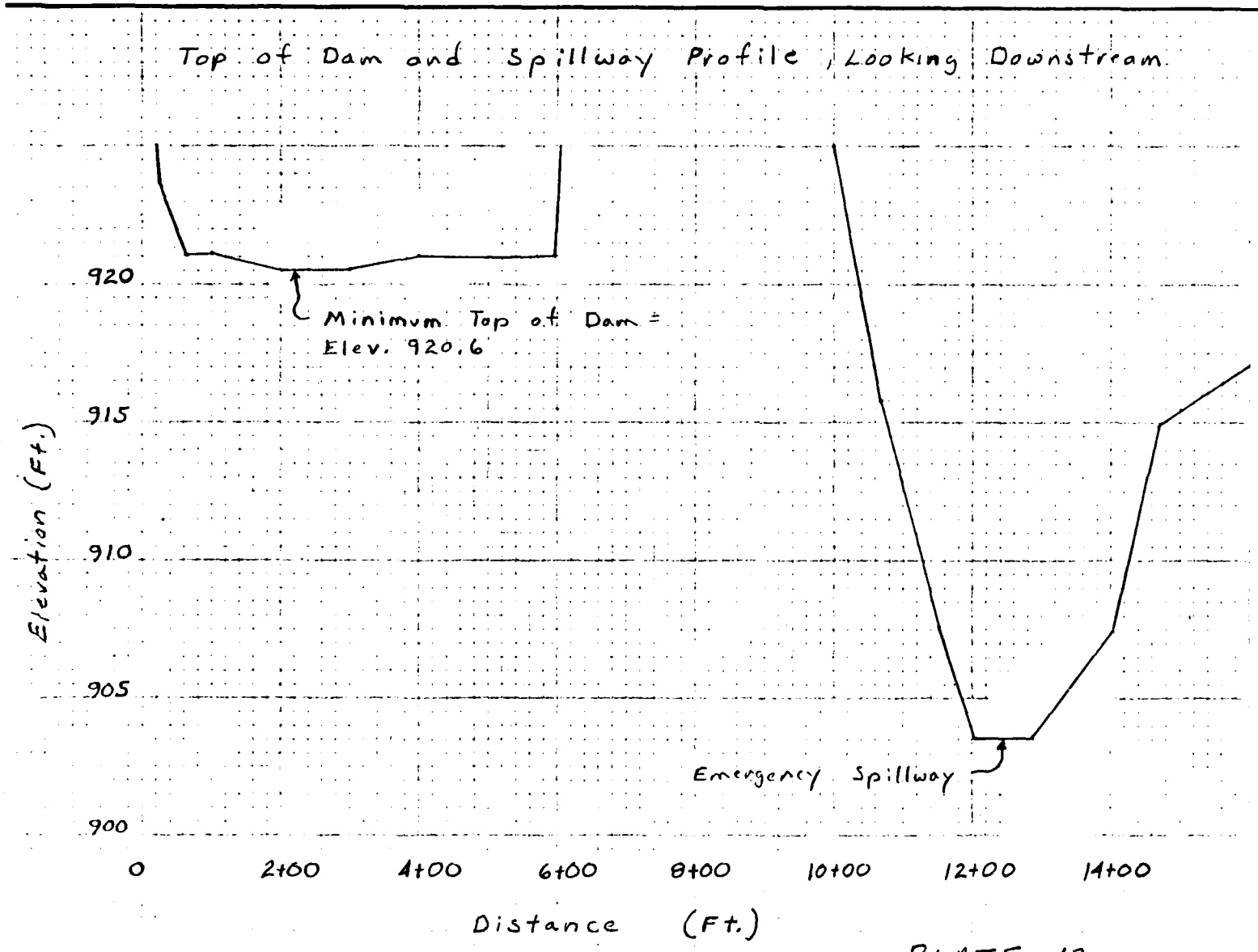


PLATE 12

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
Box 280
Beaver, Pa. 15009

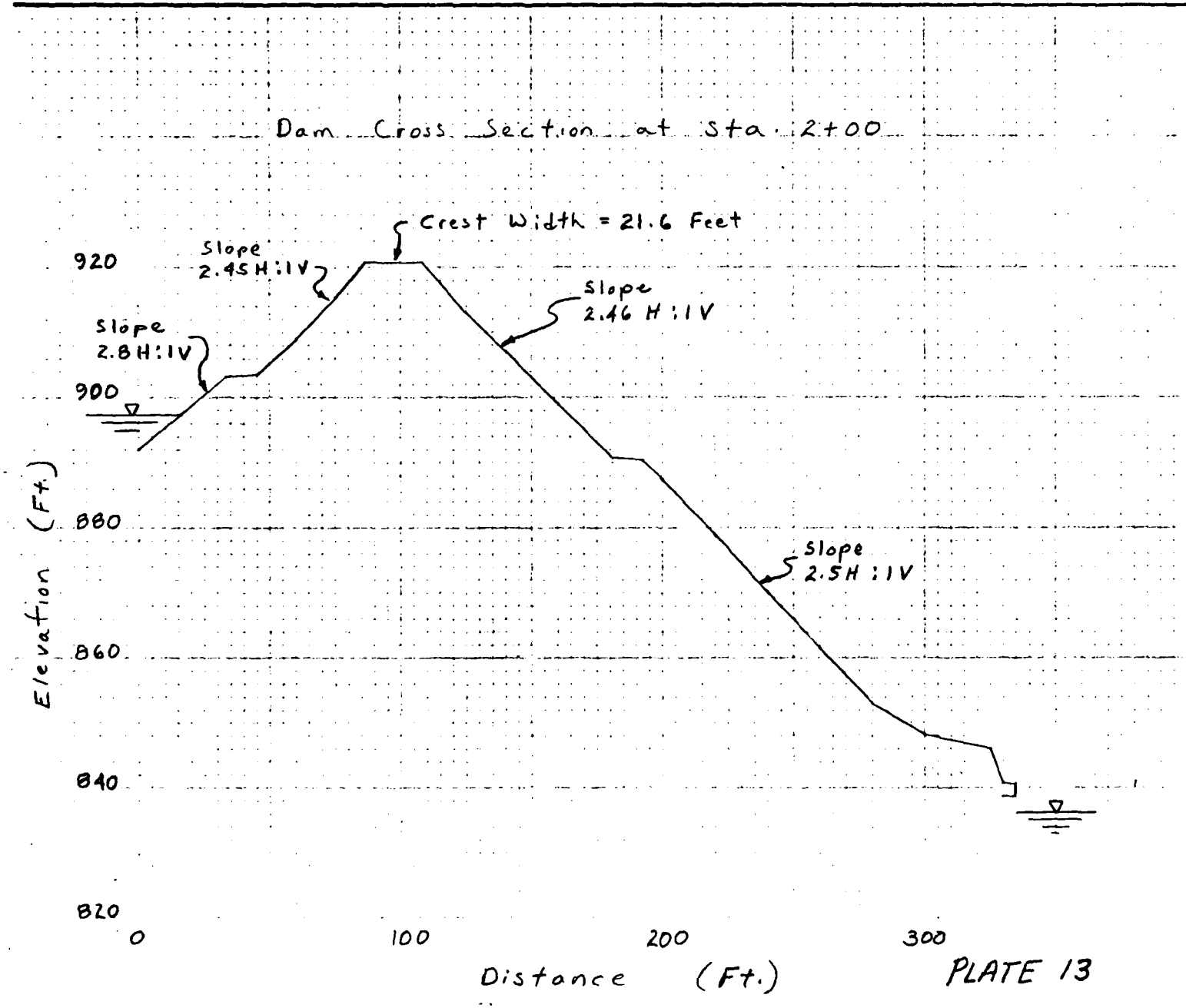


PLATE 13

APPENDIX II

PHOTOGRAPHS

CONTENTS

Note: Photographs taken on 30 October 1980.

NAME OF DAM: UNIMIN TAILINGS DAM

UNIMIN TAILINGS DAM

PHOTO 1. Emergency Spillway (Natural Saddle) and Decant Inlet

PHOTO 2. View Across Emergency Spillway Control Section
Note: Men Standing on Small Berm in Eroded Discharge Channel

PHOTO 3. Downstream Embankment, Decant Outlet and Seepage Area in Channel to Right of Decant Outlet

PHOTO 4. Decant Outlet and Stilling Basin

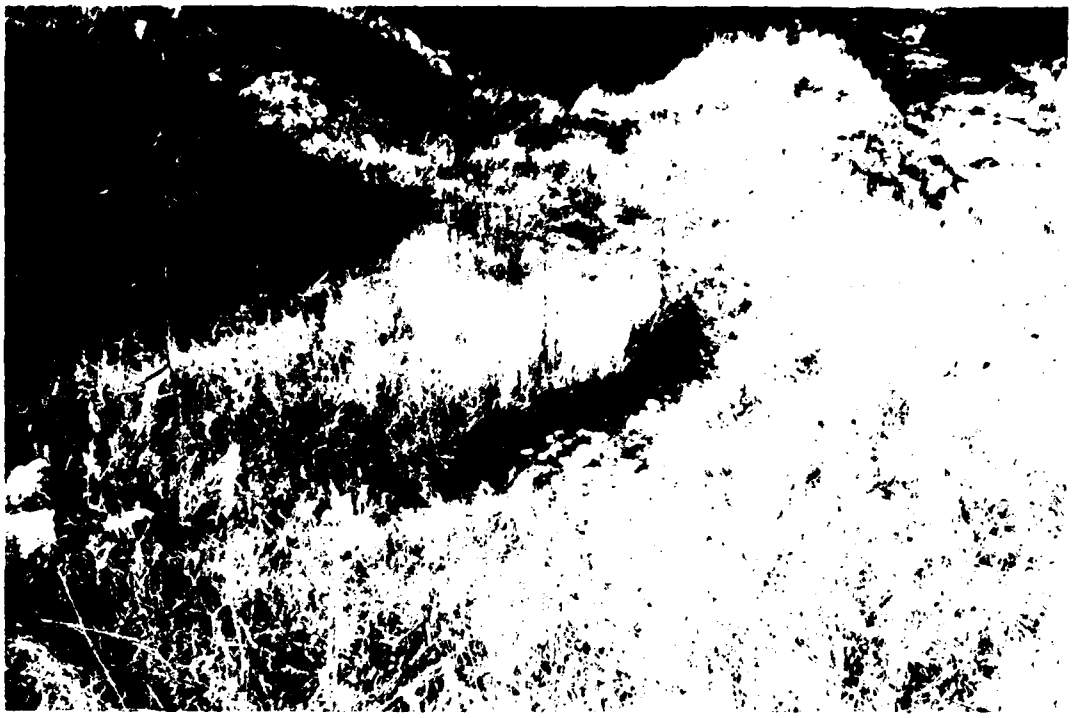


PHOTO 5. Seep Emanating from Channel Immediately Left of Decant Outlet

PHOTO 6. Erosion on Downstream Embankment

PHOTO 7. Erosion at Junction of Downstream Embankment with Left Abutment

PHOTO 8. Downstream View from Crest

APPENDIX III

VISUAL INSPECTION CHECK LIST

Check List
Visual Inspection
Phase 1

Name of Dam Unimin Tailings Dam County Frederick State Virginia Coordinates Lat. 3914.6
Long. 7820.3

Date of Inspection 30 and 31 October 1980 Weather Clear Temperature 50° F.

Pool Elevation at Time of Inspection 897.4 ft. T.B.M.* Tailwater at Time of Inspection 836.2 ft. T.B.M.*

*Elevations were referenced to a Temporary Bench Mark (T.B.M.) located on the top of a concrete marker on the top of dam, right abutment. The assumed elevation is 921.0 ft.

Inspection Personnel:

Michael Baker, Jr., Inc.:

David J. Greenwood
Larry A. Diday
David W. Hupe

Virginia State Water Control Board:

Ed Constantine

Owner's Representatives:

Keith Tubandt

David W. Hupe Recorder

EMBANKMENT

Name of Dam UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed. The ground surface of the embankment and abutments was generally dry.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	The upstream embankment and the bench just above the water line are well covered with grass. Minor erosion has occurred below the bench at the water line. The bench is a reverse terrace, and drainage sits on the back side of the terrace at times. The embankment below the bench is unvegetated and not riprapped. The embankment above the bench is not eroded. The lower half of the downstream embankment below the bench is moderately eroded. Erosion rills up to 1 ft. deep extend from the bench to the toe of the dam. A (Continued next page)	Repair all eroded areas of the embankment and establish grass cover over the sparsely vegetated areas.

EMBANKMENT

Name of Dam UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES (Continued)	few erosion rills are present on the downstream embankment above the bench. Generally, these rills do not extend up to the crest. The upper half of the downstream embankment is well vegetated, with the exception of the rills. The lower half of the downstream embankment is sparsely vegetated.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No misalignments were observed.	The dam is regularly surveyed for alignment and elevation at the control pins established. These reports were no available.
RIPRAP FAILURES		Riprap is needed on the junction areas of the downstream embankment and both abutments (below the bench).
EMBANKMENT MATERIALS	The embankment is constructed of brown silt with a little fine to medium sand and many sandstone fragments.	
OTHER	It is proposed that the present embankment soon be raised to provide additional tailing disposal.	Many of the above recommendations may be taken care of during the future enlargement of the dam.

EMBANKMENT

Name of Dam UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The right upstream embankment/abutment junction contains access roads to the crest and to the upstream bench. The slopes for the access roads are steep and subject to erosion and minor slides. However, the access roads are cut primarily into bedrock and are mostly situated on the abutment, not the dam, therefore no problems are anticipated. The left upstream junction is not eroded. The downstream embankment/abutment junctions are slightly to moderately eroded, particularly below the bench.	Repair and riprap the downstream junctions of embankment and abutment.
ANY NOTICEABLE SEEPAGE	Seepage of 3-5 g.p.m. occurs immediately to the left of the spillway outlet. This is believed to be drainage from a lateral seepage drain outlet. Very minor seepage occurs beneath the spillway outlet. No seepage was observed to the right of the outlet.	The drain(s) should be uncovered to ensure proper operation.
STAFF GAGE AND RECORDER	None present	A staff gage should be installed to monitor reservoir levels above normal pool.
DRAINS		

OUTLET WORKS

Name of Dam: UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE	The intake for the principal spillway is a 30 in. dia. B.C.C.M.P. riser. A 42 in. dia. steel pipe fits over the 30 in. pipe and is anchored with cables. Concrete fills the space between the pipes. A gate valve is attached to the riser about 4 ft. below the crest.	Operation of the gate valve lowers the reservoir pool about 4 ft. to provide more water for use downstream.
OUTLET STRUCTURE	The outlet is a 24 in. dia. B.C.C.M.P. It extends 5.5 ft. over the stilling basin without support. A large, well riprapped stilling basin is provided.	
OUTLET CHANNEL	The outlet channel drains into the reservoir for the Unimin Fresh Water impoundment immediately downstream.	The normal pool of the Fresh Water Impoundment does not submerge the toe of the Tailings Dam.
EMERGENCY GATE	N/A	

UNGATED SPILLWAY

Name of Dam: UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
EMERGENCY SPILLWAY	The emergency spillway is a broad natural saddle situated immediately right of the dam's embankment. Fill (very sandy with a lot of sandstone fragments) has been spread in the saddle area to build up the level of the emergency spillway. The fill is generally unvegetated. A definite channel is visible, but a narrow dam or temporary roadway runs across the channel. The narrow dam is not sufficiently wide to resist an impounding of water behind it for an extended period of time, nor will it resist rapid erosion if overtopped.	A good grass cover should be established over the sparsely vegetated areas of the emergency spillway.
APPROACH CHANNEL	The approach channel is wide and unobstructed. The channel is generally unvegetated.	A good grass cover should be established over the entire channel.
DISCHARGE CHANNEL	The unobstructed discharge channel runs through the fill materials discussed above and is only sparsely vegetated.	A good grass cover should be established over the entire channel.
BRIDGE AND PIERS	N/A	

INSTRUMENTATION

Name of Dam: UNIMIN TAILINGS DAM

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed	
OBSERVATION WELLS	None present	
WEIRS	None present	
PIEZOMETERS	One piezometer near each end of dam crest and a cluster (3 piezometers) on the crest near the center. Left piezometer - 60 ft. to bottom with no water. The other piezometers on the crest were plugged near the surface and could not be measured. A cluster of 3 piezometers is located on the bench of the downstream embankment (center of bench). The piezometer with the highest elevation could not be measured dut to equipment malfunction. The next lower piezometer measured 15.17 ft. to the bottom and was dry. The lowest piezometer measured 32.87 ft. to the bottom and was dry.	
OTHER		

RESERVOIR

Name of Dam: UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes are steep and heavily wooded. The banks of the reservoir are well vegetated with grasses and some trees down to the edge of the banks. No indications of significant erosion were observed.	
SEDIMENTATION	Soundings taken show water to be approximately 5 ft. deep at the spillway riser.	

DOWNSTREAM CHANNEL

Name of Dam: UNIMIN TAILINGS DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The Unimin Fresh Water Pond is immediately downstream. The connecting channel is unobstructed. Downstream of the Fresh Water Pond Dam there is some minor debris, a small pile of junk and a trailer in the channel.	
SLOPES	The channel downstream of the Fresh Water Pond Dam is a natural stream channel with about a 2% slope. The side slopes are steep and covered with trees and brush.	
APPROXIMATE NO. OF HOMES AND POPULATION	Three homes are located about 1.0 mi. downstream, one business (C.E. Minerals) about 1.2 mi. downstream, and three more homes about 1.4 mi. downstream. These structures are located about 10 to 15 ft. above the streambed.	

APPENDIX IV

GENERAL REFERENCES

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